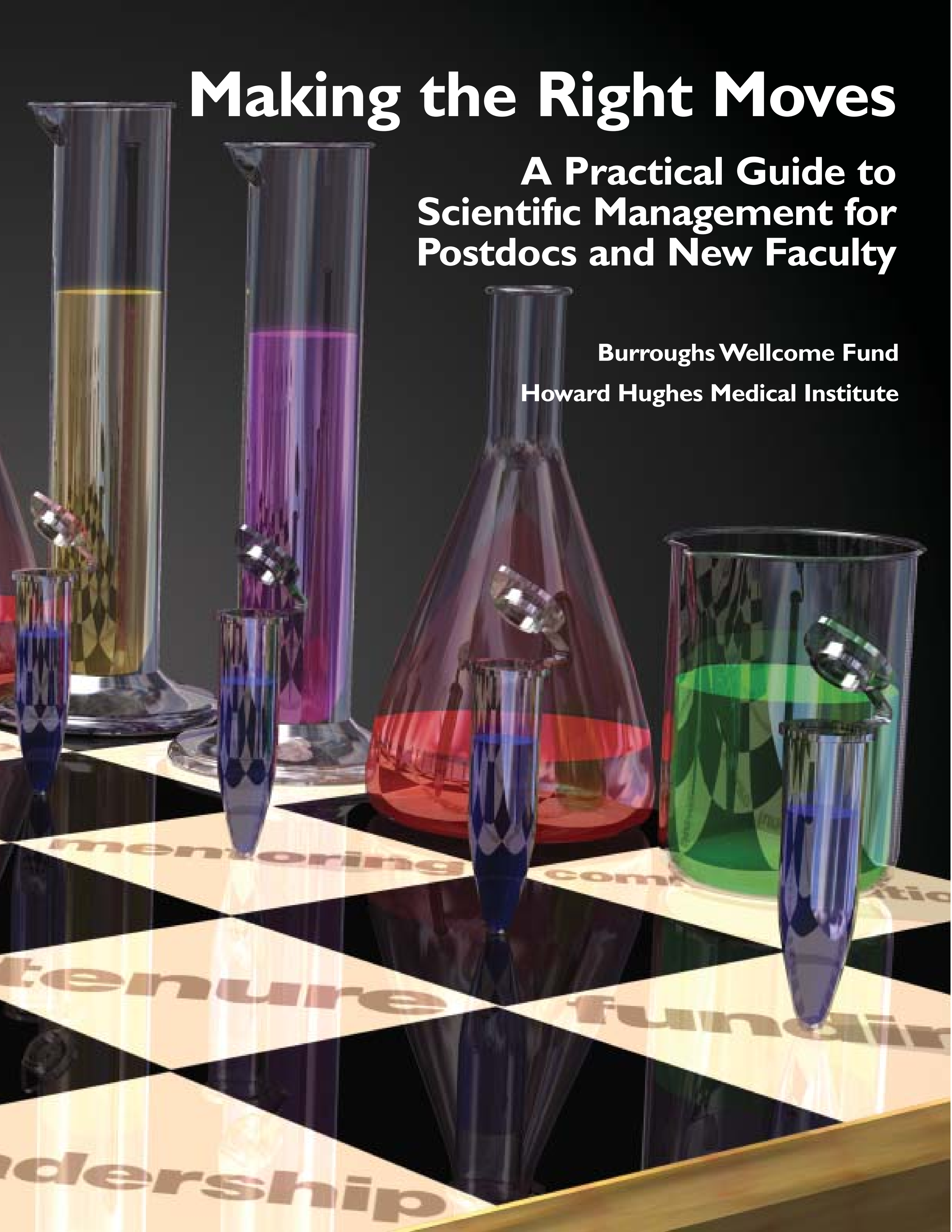
Making the Right Moves

A Practical Guide to Scientific Management for Postdocs and New Faculty

Burroughs Wellcome Fund

Howard Hughes Medical Institute



Making the Right Moves

A Practical Guide to Scientific Management for Postdocs and New Faculty

Based on the BWF-HHMI Course in Scientific Management for the Beginning Academic Investigator

Burroughs Wellcome Fund
Research Triangle Park, North Carolina

Howard Hughes Medical Institute
Chevy Chase, Maryland

Project Developers: Maryrose Franko, Ph.D., and Martin Ionescu-Pioggia, Ph.D.
Editor: Laura Bonetta, Ph.D.
Managing Editor: Patricia Davenport
Production Manager: Dean Trackman
Designer: Raw Sienna Digital
Writers: Joan Guberman, Barbara Shapiro, and Marion Torchia
Copyeditors: Cay Butler, Linda Harteker, and Kathleen Savory
Indexer: Mary E. Coe

BURROUGHS WELLCOME FUND

21 T.W. Alexander Drive
P.O. Box 13901
Research Triangle Park, North Carolina
27709-3901
http://www.bwfund.org

HHMI
HOWARD HUGHES MEDICAL INSTITUTE

4000 Jones Bridge Road
Chevy Chase, Maryland 20815-6789
http://www.hhmi.org

Contents

budget
publications

Preface

This manual is based on the "Course in Scientific Management for the Beginning Academic Investigator," held in July 2002 at Howard Hughes Medical Institute (HHMI) headquarters in Chevy Chase, Maryland. This intensive course was sponsored and developed by the Burroughs Wellcome Fund (BWF) and HHMI. About 130 current and former BWF and HHMI grantees attended. Participants were either newly appointed faculty in research universities or senior postdoctoral fellows looking for faculty positions.

The idea for the course grew out of feedback that BWF and HHMI staff had solicited over the years from the talented young biomedical scientists who had received research training or career development grants from the organizations. These beginning investigators described the challenges they faced in having to fulfill their research, teaching, administrative, and clinical responsibilities while simultaneously being expected to obtain grant support, publish, hire staff, and keep their labs running smoothly—all without formal management training. Their comments suggested that the grantees might have avoided costly mistakes and made better progress if they had learned to be managers as well as researchers before establishing their own laboratories.

Because BWF and HHMI have similar missions—to advance medical science by funding scientific research and education—and have grant programs that support beginning biomedical investigators, a collaboration to establish this course seemed appropriate. The two organizations were already involved in the joint funding and development of the Career Development Center, which focuses on issues facing the beginning academic investigator. It is located at *Science*'s Next Wave Web site and operated by staff of the American Association for the Advancement of Science.

It took about two years for the course to take shape. To determine what specific information should be included, BWI and HHMI staff conducted surveys and focus groups with current and former grantees and senior scientists affiliated with both organizations. The final program covered a range of topics, from laboratory leadership and mentoring skills to getting published and time management. The course, which included a lively combination of plenary sessions, workshops, panel discussions, and opportunities for networking, received an exceptionally enthusiastic response.

In the postcourse focus groups and surveys, participants said that a manual based on the course would be a valuable reference for them, for colleagues who could not attend the course, and for those wanting to develop their own courses on scientific management. This manual responds to their request.

This manual is intended for laboratory-based biomedical scientists just starting out—advanced postdoctoral fellows ready to enter the academic job market and new faculty members in research universities and medical schools. Much of the material, however, is also relevant to scientists pursuing nonacademic career paths. The purpose of the manual is to alert beginning scientists to the importance of the managerial aspects of their new (or soon-to-be-acquired) jobs and to give them practical information that will help them succeed as planners and managers of research programs.

The manual is also intended to encourage universities, professional societies, postdoctoral associations, and other organizations to develop similar courses in scientific management and to provide these organizations with an example of how such courses might be designed. BWF and HHMI believe that training in scientific management should be made available to all researchers early in their careers. Not only will the researchers benefit, but the scientific enterprise will benefit as well.

Enriqueta C. Bond, Ph.D.
President
Burroughs Wellcome Fund

Thomas R. Cech, Ph.D.
President
Howard Hughes
Medical Institute

Peter J. Bruns, Ph.D.
Vice President
Grants and Special
Programs
Howard Hughes
Medical Institute

Acknowledgments

This manual and the course on which it is largely based owe their existence to many people. Maryrose Franko (HHMI) and Martin Ionescu-Pioggia (BWF) advocated for both projects, guided their development, and brought them to completion. Laura Bonetta, science writer and course coordinator, and Pat Davenport (HHMI) were crucial to shaping the content of the manual and managing the editorial process. Jim Austin (American Association for the Advancement of Science), Victoria McGovern (BWF), Rolly L. Simpson (BWF), and Andrea L. Stith (formerly HHMI and now at the Federation of American Societies for Experimental Biology) organized many of the course sessions and reviewed the relevant chapters for the manual.

A number of BWF and HHMI grant recipients and senior scientists participated in precourse focus groups and interview sessions, providing invaluable suggestions for designing the course. Some of them, along with other professionals, served as course faculty and contributed to the content of the manual by responding generously to requests for interviews and additional information and by reviewing chapter drafts. Management consultants Christine Harris and Joan C. King developed a workshop in basic laboratory leadership skills for the course and allowed us to include in the manual material they had used to develop that workshop. Krystyna R. Isaacs, evaluation consultant, analyzed the data from the course evaluations.

Milton W. Datta (Medical College of Wisconsin) and Tom Misteli (National Cancer Institute, National Institutes of Health) deserve special acknowledgment. Both took the time on several occasions to be interviewed, and they provided detailed information on a variety of topics. Thanks also to Joan E. Dubinsky, Heidi E. Henning, and Carl Rhodes of HHMI for their careful review of the chapters.

Writers Joan Guberman, Barbara Shapiro, and Marion Torchia synthesized information presented during the course and conducted additional research to draft chapters of the manual. HHMI librarian Cathy Harbert suggested and obtained additional resources for the writers and course organizers. HHMI's Dean Trackman managed the production process; Cay Butler, Linda Harteker, and Kathleen Savory provided additional editorial support; and Mary E. Coe created the index. Cathy Newton, Adam Newton, and Tom Wood (Raw Sienna Digital) designed the manual.

budget
publications

Contributors

David J. Adams, Ph.D.
Associate Research Professor of Medicine, Department of Medicine
Duke University Medical Center
Durham, North Carolina

Jim Austin, Ph.D.
Senior Editor, *Science*'s Next Wave
American Association for the Advancement of Science
Washington, D.C.

W. Emmett Barkley, Ph.D.
Director of Laboratory Safety
Howard Hughes Medical Institute
Chevy Chase, Maryland

Enriqueta C. Bond, Ph.D.
President
Burroughs Wellcome Fund
Research Triangle Park, North Carolina

Laura Bonetta, Ph.D.
Science Writer and Course Coordinator
Bethesda, Maryland

Peter J. Bruns, Ph.D.
Vice President, Grants and Special Programs
Howard Hughes Medical Institute
Chevy Chase, Maryland

Gail H. Cassell, Ph.D.
Vice President, Scientific Affairs
Eli Lilly and Company
Indianapolis, Indiana

Thomas R. Cech, Ph.D.
President
Howard Hughes Medical Institute
Chevy Chase, Maryland

R. Alta Charo, J.D.
Associate Dean, Research and Faculty Development
University of Wisconsin Law School
Madison, Wisconsin

Anthony M. Coelho Jr., Ph.D.
Review Policy Officer, Office of Extramural Research
Office of the Director, National Institutes of Health
Bethesda, Maryland

Martha J. Connolly, Ph.D.
Director, Maryland Industrial Partnerships
Maryland Technology Enterprise Institute
College Park, Maryland

Ronald B. Corley, Ph.D.
Professor and Chairman, Department of Microbiology
Boston University School of Medicine
Boston, Massachusetts

Milton W. Datta, M.D.
Assistant Professor of Pathology and Urology
Medical College of Wisconsin
Milwaukee, Wisconsin

Anthony Demsey, Ph.D.
Senior Advisor for Policy, Office of Extramural Research
Office of the Director, National Institutes of Health
Bethesda, Maryland

Joseph DeRisi, Ph.D.
Assistant Professor, Department of Biochemistry and Biophysics
University of California–San Francisco
San Francisco, California

Tamara L. Doering, M.D., Ph.D.
Assistant Professor, Department of Molecular Microbiology
Washington University School of Medicine
St. Louis, Missouri

Joan E. Dubinsky, J.D.
Associate Director, Employee Development
Howard Hughes Medical Institute
Chevy Chase, Maryland

Angela Eggleston, Ph.D.
Senior Editor
Cell Press
Cambridge, Massachusetts

B. Brett Finlay, Ph.D.
Professor, Biotechnology Laboratory, and Departments of Biochemistry and Molecular Biology, and Microbiology and Immunology
University of British Columbia
Vancouver, British Columbia

Maryrose E. Franko, Ph.D.
Senior Program Officer, Office of Grants and Special Programs
Howard Hughes Medical Institute
Chevy Chase, Maryland

Claire M. Fraser, Ph.D.
President and Director
The Institute for Genomic Research
Rockville, Maryland

William R. Galey, Ph.D.
Director, Graduate Science Education and Medical Research Training Program
Howard Hughes Medical Institute
Chevy Chase, Maryland

Chris M. Golde, Ph.D.
Senior Scholar
Carnegie Foundation for the Advancement of Teaching
Menlo Park, California

Todd R. Golub, M.D.
HHMI Associate Investigator and Charles A. Dana Investigator in Human Cancer Genetics
Dana-Farber Cancer Institute
Boston, Massachusetts

Bettie J. Graham, Ph.D.
Program Director, National Human Genome Research Institute
National Institutes of Health
Bethesda, Maryland

Stephen L. Hajduk, Ph.D.
Director, Program in Global Infectious Diseases
Marine Biological Laboratory
Woods Hole, Massachusetts

Christine Harris, Ed.D.
Executive Coach and Management Consultant
Cambridge, Massachusetts

Heidi E. Henning, J.D.
Associate General Counsel
Howard Hughes Medical Institute
Chevy Chase, Maryland

Mark A. Hermodson, Ph.D.
Professor of Biochemistry, Department of Biochemistry and Molecular Biology
Purdue University
West Lafayette, Indiana

Martin Ionescu-Pioggia, Ph.D.
Senior Officer
Burroughs Wellcome Fund
Research Triangle Park, North Carolina

Krystyna R. Isaacs, Ph.D.
Evaluation Specialist
Coppell, Texas

Myra L. Jackson
Training Designer, Employee Development
Howard Hughes Medical Institute
Chevy Chase, Maryland

Howard Kanare
Senior Principal Scientist
Construction Technology Laboratories
Skokie, Illinois

Elizabeth Keath, Ph.D.
Associate Professor, Department of Biology
Saint Louis University
St. Louis, Missouri

Joan C. King, Ph.D.
Professor Emerita
Tufts University School of Medicine
Boston, Massachusetts

Michael E. McClure, Ph.D.
Chief, Organs and Systems Toxicology Branch
National Institute of Environmental Health Sciences
National Institutes of Health
Bethesda, Maryland

Mary McCormick, Ph.D.
Scientific Review Administrator
Center for Scientific Review, National Institutes of Health
Bethesda, Maryland

Victoria McGovern, Ph.D.
Program Officer
Burroughs Wellcome Fund
Research Triangle Park, North Carolina

Francis J. Meyer, Ph.D.
Vice President, Enterprise Development
A. M. Pappas & Associates
Research Triangle Park, North Carolina

Tom Misteli, Ph.D.
Principal Investigator, Cell Biology of Gene Expression Group
National Cancer Institute, National Institutes of Health
Bethesda, Maryland

Christopher T. Moulding
Science Administrator
Howard Hughes Medical Institute
Chevy Chase, Maryland

Charles E. Murry, M.D., Ph.D.
Associate Professor, Department of Pathology
University of Washington School of Medicine
Seattle, Washington

Klaus R. L. Nüsslein, Ph.D.
Assistant Professor, Department of Microbiology
University of Massachusetts–Amherst
Amherst, Massachusetts

Suzanne Pfeffer, Ph.D.
Professor and Chairman, Department of Biochemistry
Stanford University School of Medicine
Stanford, California

Stanley E. Portny
President
Stanley E. Portny and Associates
Short Hills, New Jersey

Rudy Pozzatti, Ph.D.
Scientific Review Administrator
National Human Genome Research Institute,
National Institutes of Health
Bethesda, Maryland

Richard M. Reis, Ph.D.
Executive Director, Alliance for Innovative Manufacturing
Stanford University
Stanford, California

Carl Rhodes, Ph.D.
Scientific Officer
Howard Hughes Medical Institute
Chevy Chase, Maryland

David S. Roos, Ph.D.
Merriam Professor of Biology
University of Pennsylvania
Philadelphia, Pennsylvania

Sandra L. Schmid, Ph.D.
Chairman, Department of Cell Biology
The Scripps Research Institute
La Jolla, California

Dorothy E. Shippen, Ph.D.
Professor of Biochemistry and
Biophysics, Faculty of Genetics
Texas A&M University
College Station, Texas

Rolly L. Simpson
Program Associate
Burroughs Wellcome Fund
Research Triangle Park, North Carolina

Dianne J. Smith, J.D.
Associate General Counsel
Howard Hughes Medical Institute
Chevy Chase, Maryland

Andrea L. Stith, Ph.D.
Policy Analyst
Federation of American Societies for
Experimental Biology
Bethesda, Maryland

Rick Tarleton, Ph.D.
Distinguished Research Professor,
Department of Cellular Biology
University of Georgia
Athens, Georgia

Laurie Tompkins, Ph.D.
Program Director, Division of Genetics
and Developmental Biology
National Institute of General Medical
Sciences, National Institutes of Health
Bethesda, Maryland

Gina Turrigiano, Ph.D.
Associate Professor, Department of
Biology and Center for Complex
Systems
Brandeis University
Waltham, Massachusetts

Joseph M. Vinetz, M.D.
Associate Professor, Departments of
Pathology, Internal Medicine, and
Microbiology and Immunology
University of Texas Medical
Branch–Galveston
Galveston, Texas

Tony G. Waldrop, Ph.D.
Vice Chancellor for Research and
Economic Development
University of North Carolina–Chapel
Hill
Chapel Hill, North Carolina

Johannes Walter, Ph.D.
Assistant Professor, Department of
Biological Chemistry and Molecular
Pharmacology
Harvard Medical School
Boston, Massachusetts

Christopher Wylie, Ph.D.
Director, Division of Developmental
Biology
Cincinnati Children's Hospital Research
Foundation
Cincinnati, Ohio

E. Lynn Zechiedrich, Ph.D.
Assistant Professor, Department of
Molecular Virology and Microbiology
Baylor College of Medicine
Houston, Texas

Introduction

You are now a fully trained biomedical research scientist. You have earned a Ph.D. or an M.D. or both and have spent several years as a postdoctoral fellow learning the ropes of your specialty. You have the credentials you need for a career as an academic researcher.

But as you establish your own laboratory and build your research program, you are becoming aware that research skills are only part—albeit a critical part—of what you need to succeed. In your first few years as a tenure-track faculty scientist, you will be asked to balance multiple new demands on top of your research, including teaching, administrative tasks, and perhaps clinical responsibilities. At the same time, you will be expected to hire staff and establish a laboratory, plan a coherent research program, obtain grant funding, and publish in the top journals. Meanwhile, your tenure clock will be ticking, placing you under enormous pressure to produce. You need special skills to meet all these expectations—a mixed bag of competencies that can be loosely characterized as "scientific management" skills.

> *Why do we need something like a lab management course? Biomedical research today is a complex enterprise that spans multiple biological levels, requires a variety of equipment and staff, and demands success with limited funds. Each one of you is really an entrepreneur running your own new small business.*
>
> —Enriqueta Bond, Burroughs Wellcome Fund

Unfortunately, it is unlikely that you have received explicit instruction in any of these skills in graduate or medical school or during your postdoctoral studies. Like most beginning investigators, you probably were only able to learn a bit through trial and error or by watching your teachers and talking to your advisers, mentors, and fellow students.

This manual provides an outline for filling this educational gap. The content is based on the "Course in Scientific Management for the Beginning Academic Investigator," held at Howard Hughes Medical Institute (HHMI) headquarters in July 2002. The course was developed and sponsored by the Burroughs Wellcome Fund (BWF) and HHMI for selected BWF and HHMI grantees. BWF and HHMI staff developed the course out of a conviction that scientific management is a teachable subject—that it is possible for beginning scientists to learn how successful scientists manage their research programs. The course covered basic topics in scientific management, including laboratory leadership, getting funded, time management, and collaborations, to give participants a head start in achieving research independence. (Chapter 13 presents detailed information on the development and content of the course.) Although the manual is directed to laboratory-based academic scientists, much of the material would also be of use to beginning investigators in government and industry labs.

The chapters in this manual were developed from the course presentations and panel discussions, handouts from presenters, the question-and-answer (Q&A) sessions, feedback from course participants, and subsequent interviews with the presenters and other scientists. Content was also drawn from many of the resources listed at the end of each chapter. Additional information was obtained from transcripts of interviews with "model laboratory leaders" that had been conducted by executive coaches Christine Harris, Ed.D., and Joan C. King, Ph.D., when they were designing a workshop on basic laboratory leadership skills that they conducted as part of the course.

The first chapter, "Obtaining and Negotiating a Faculty Position and Planning for Tenure," offers tips on finding and negotiating terms for a faculty position, outlines the expectations of a faculty job, and offers a timeline to help you plan for tenure. The next chapter, entitled "The Scientific Investigator Within the University Structure," takes a look at the typical decision-making hierarchy of a research university and an academic health center, discusses your professional responsibilities outside the laboratory, and introduces some of the academic offices with which you will interact and the resources available to support your research.

Two chapters deal with people skills. "Defining and Implementing Your Mission" offers guidance in developing a mission statement for your lab and suggests ways to motivate and manage the people in your lab. "Mentoring and Being Mentored" explores what it means to be a mentor, particularly as a strategy for facilitating learning and training new scientists. It includes approaches to help you be an effective mentor and offers advice on how to obtain the mentoring you need.

"Staffing Your Laboratory" provides pointers on recruiting a team of people who will contribute to the success of your lab. It also discusses what to do if you have to let someone go. (The course did not cover this subject, but its importance emerged during the Q&A sessions, as grantees asked for guidance on difficult personnel issues they were facing.)

Several chapters offer tips about time management, project management, and data management. "Getting Funded" and "Getting Published and Increasing Your Visibility" discuss these challenging tasks in the competitive environment of biomedical research. "Setting Up Collaborations" and "Understanding Technology Transfer" are particularly relevant at a time when research projects often involve scientists in different departments and different universities and when research findings are often shared with industry and government. The final chapter provides a summary of the course, including an abstract of each session, a summary of the postcourse evaluation and lessons learned, and speakers' biographies.

Several sessions of the course were not developed into separate chapters in the manual, but some of the information from these sessions is included in various chapters. For example, information from the session on budgets is found in the chapter "Getting Funded," in the context of preparing a grant application. Given time and space constraints, some topics, such as lab safety, scientific writing, public speaking, communicating science to the public, and science policy, were not covered in either the course or the manual. This information is typically taught at most universities or is available from other sources (e.g., HHMI has published several videos on laboratory safety, available at no charge from HHMI's online catalog at ***http://www.hhmi.org/catalog***).

Each chapter was reviewed by the session speaker(s), course developers, and other BWF and HHMI staff. The manual is not meant to be a comprehensive reference text. It is designed to highlight key points about scientific management that are not readily available in print elsewhere. The manual is likewise not meant to be prescriptive. It is a collection of opinions, experiences, and tips from established scientists and professionals. You are encouraged to supplement this information with resources from postdoctoral or professional associations and Web resources, as well as the books and articles mentioned in each chapter. You are also encouraged to discuss ideas in the book with colleagues, mentors, and advisers. It is hoped that these discussions will spark ideas for developing a scientific management style that suits your personality and professional situation. The manual can also serve as a resource for organizations that are developing their own courses in scientific management.

budget
publications

Chapter 1

OBTAINING AND NEGOTIATING A FACULTY POSITION AND PLANNING FOR TENURE

This chapter is based on the session "Obtaining and Negotiating a Faculty Position" that was held at the BWF-HHMI Course in Scientific Management. The session was organized by Rolly L. Simpson, Burroughs Wellcome Fund, with presentations by Chris M. Golde, Ph.D., Carnegie Foundation for the Advancement of Teaching; Johannes Walter, Ph.D., Harvard Medical School; and Christopher Wylie, Ph.D., Cincinnati Children's Hospital Research Foundation. Additional information was obtained from Peter J. Bruns, Ph.D., Howard Hughes Medical Institute (HHMI); Milton W. Datta, M.D., Medical College of Wisconsin; Todd R. Golub, M.D., Dana-Farber Cancer Institute (also HHMI associate investigator); Carl Rhodes, Ph.D., HHMI; Tony G. Waldrop, Ph.D., University of North Carolina–Chapel Hill; and some of the resources noted in this chapter.

As you complete your postdoctoral training, you are probably starting to think about the next step in your research career. For some of you, this may mean a position as an investigator in an industry or government laboratory. For others, this may mean a faculty position at a university or medical center. If you pursue the latter, you will have to decide whether a tenured or nontenured position is better suited to your personal goals and ambitions. Although all these career options are rewarding, this chapter focuses on the tenure-track faculty appointment.

As you embark on your search, you will face a series of challenging questions:

- What do I want and need from my job?
- How do I go about finding a job?
- How can I ensure that my achievements and capabilities will be recognized?
- How will I choose among the offers I receive?
- How can I ensure that the resources I need to launch my career are included in the job package?
- How can I increase my chances of getting promoted and obtaining tenure?

There are no universally right answers to these questions, but there are well-tested strategies for finding and obtaining the right academic appointment and for obtaining tenure. This chapter discusses some of them.

OBTAINING A FACULTY POSITION

The Job Search

Once you decide to launch your search, make it a concentrated effort. Ideally, doing so will bring multiple offers your way at about the same time. Making the job hunt a flat-out effort also makes the labor-intensive process of gathering credentials and references much more worthwhile. Keep in mind that most academic positions are advertised in the fall, with the assumption that the job will start in summer or fall of the following year.

Knowing what you want. Your chances of finding the right job will be greater if you have your own needs and wants firmly in mind. For example, consider the following questions:

- Do you need to be working at a top-rated institution, or would a less-intense atmosphere be acceptable or even preferable, given your talents and ambitions?
- Do you want to devote yourself exclusively to research, or would you prefer some combination of research and teaching or clinical practice?
- Do you want or need to be in a particular area of the country? Do you prefer an urban, rural, or suburban location?
- Will personal responsibilities, or your spouse's or partner's professional needs, set limits on your search?

In addition, if you are a physician-scientist, you will have to decide whether you want to be more of a researcher or more of a clinician.

A Few Career-Related Web Sites for Scientists

Science magazine's Next Wave Web site contains a Career Development Center for postdocs and beginning faculty (*http://nextwave.sciencemag.org/cdc/*).

The Chronicle of Higher Education's online newsletter *Career Network* has career news and advice and publishes new scientific faculty and research jobs every day (*http://chronicle.com/jobs*).

The University of Washington's *Re-envisioning the Ph.D.* provides Web resources related to job hunting for doctoral students, postdocs, and academics (*http://www.grad.washington.edu/envision/phd/employment_index.html*).

Learning what is out there. Use all available formal and informal sources of information. Formal sources of information include the following:

- Job announcement letters sent to your department
- Announcements (print and online) in major scientific journals such as *Cell*, *Science*, and *Nature* and in publications devoted to your subspecialty
- Web sites of academic institutions
- Employment bulletins published by professional associations

Informal sources can be even more valuable—for example, the supervisor of your postdoctoral research; other scientists with whom you have a relationship, especially those with whom you have collaborated; and your peers. So, get the word out that you are looking.

Narrowing your search. Measure each job opportunity against your list of priorities. Find out about

- The institution's mission, values, political and social climate, and quality (e.g., national or regional ranking)
- The department's mission, research activities, curriculum, and collegial atmosphere
- The parameters and expectations of the position, including whether it is tenure track

There's no easy way to tell how many positions to apply for. Remember, though, job hunting is not wasted time; the process has valuable spin-offs. For example, you will get a chance to make presentations about your work. Your ideas are sharpened in the process, and the research itself benefits. You are practicing skills you will use throughout your career. You also get better at the job-hunting process as you go along. Your self-confidence builds, and your sense of what you want develops as you are introduced to various research environments.

However, don't apply for a job that you are clearly not qualified for or that really does not interest you. You don't want to waste people's time and perhaps damage your own credibility.

The Job Application

Once you have found one or several positions that you would like to apply for, you want your application to stand out sufficiently so that you will be invited for an interview. Here are some guidelines.

First impressions. Your application is likely to be one of hundreds that an overworked search committee must sift through. Follow the application instructions, and make sure your application is concise and free of factual, grammatical, and spelling errors. You don't want it eliminated at the outset because it makes a bad impression.

Get your application in on time. However, if you learn about the position after the application deadline has passed, still send in your application; many departments are willing to consider late applications.

> *While a nicely prepared application will obviously not get you a job, a poorly prepared one makes a bad impression no matter how many papers you have published.*
>
> —Johannes Walter, Harvard Medical School

The cover letter. This letter, which should be limited to one page, is extremely important and should be written with great care. It should give the search committee a quick but informative picture of your background and interests relevant to the job. Include the following items in your letter:

- Brief self-introduction
- Statement specifying the position for which you are applying
- Statement about your research accomplishments, indicating why the work is novel and interesting
- Brief description of your research plans, indicating what is important or creative about what you propose
- Brief description of your teaching (or clinical) experience, if the position emphasizes these activities
- Any special circumstances you believe the committee should know about up front

Two-Academic-Career Couples

"Partner hire" packages, in which a job is found for the accompanying spouse or partner, take considerable work. You should put this item on the table early in the interview process—certainly before you receive an offer. You will learn whether the university, and your prospective department, views two-career appointments positively or as a nuisance.

The last item may be a difficult judgment call. It is hard to know whether to reveal information that could eliminate you as a candidate before you've even had an interview but that will need to be addressed should you receive an offer. The classic example of such a situation is that your spouse is also a scientist looking for a faculty appointment. If you decide not to mention such a circumstance in your cover letter, inform the search committee of your special needs early in the interview process.

If you have the names of your references, include them in your letter and be sure to describe how they know you.

The curriculum vitae (CV). This career summary should contain:

- Your name and address
- All higher education, with degrees obtained and dates
- All professional positions held, with dates and brief descriptions of the work performed
- Awards and honors, including pre- and postdoctoral fellowships
- Major sources of independent funding
- Publications
- Teaching experience and interests
- References, including names, titles, and addresses and other contact information

Highlight your name in bold type in your publications list. If you are listed as an equal author on a paper, use an asterisk next to your name and all other authors who are equal and note "*equal authorship" immediately below the relevant reference. *Do not rearrange the published order of authors to show that you have equal first authorship.* List manuscripts in preparation under a separate category. Indicate accompanying *News & Views* articles or other reviews of your publications. Do not include posters exhibited at scientific meetings.

The research proposal. This is the core of your application. It will describe your research plans to a search committee composed of people from several scientific areas outside your subspecialty.

Many successful applicants write two (or possibly three) research proposals, the first of which is closely related to their current postdoctoral work. The second and third proposals show the applicant's ability to think beyond his or her current work. These proposals are typically more creative and demonstrate a bit more risk. Include the following items in your proposals:

- A statement about the problem you intend to work on, indicating the key unanswered questions you will tackle. State how this research is expected to contribute to your general area.
- A description of your research plans. This section should comprise 50 to 70 percent of the proposal. Put forward three or four specific aims that address a range of fundamental questions within your discipline. Demonstrate that you have the necessary background to achieve what you propose. Be both creative and realistic.
- A few figures (perhaps one per proposal). These can help make your proposal more interesting to the search committee, which will be wading through perhaps hundreds of proposals from the other applicants. Remember, figures are most useful when they're embedded in the text and not tacked on at the end.
- A detailed description of your postdoctoral research, with an emphasis on what is novel and important and how it is the basis for your research proposal. Describe your predoctoral graduate research only if it is critical to your current interests.
- A list of references that includes your publications and manuscripts submitted or in press, as well as pertinent publications by others.

Reprints. Follow the directions for each application. Send along any important papers that are not yet published; otherwise, the committee will not have access to them.

Statement of teaching. If the job has a teaching component, add a separate section describing your interest in and approach to teaching and your experience.

Letters of recommendation. Depending on the application instructions, letters of recommendation can be included in the application package or submitted subsequently to the search committee. Typically, these letters are written by your graduate and postdoctoral advisers. It is also perfectly acceptable to submit one or two more references than the number asked for in the application. When you approach someone other than an adviser for a letter of recommendation, use the conversation as an opportunity to get a sense of how they judge your work. If you encounter any

Question: What if I don't get along with my adviser?

Answer: If you do not have a good relationship with your adviser and cannot ask for a letter of recommendation, make sure you explain *why* in your cover letter. Be completely candid about the situation. Not having a recommendation from your adviser is a red flag to the search committee and will not be ignored. The committee may even contact your adviser anyway. A letter from another faculty member from the same institution may be critical in this case.

hesitation at all, or an indication that the person does not have time to write a letter or does not know you well enough to do so, ask others. You should ask someone who really knows you and your work, not just someone with an important title.

Give those who are writing you a letter of recommendation plenty of time to prepare the letter. Give them your application package. If they suggest, prepare a draft of the letter of recommendation for them. Point out strengths you have that they may not be fully aware of. But be careful—do not appear to be dictating your letter to them. Provide them with stamped, addressed envelopes. Tell them when each letter to each of your potential employers will be needed, and then remind them until they send your letters. Check to verify that each letter has been received.

The Job Interview

A formal interview for a faculty position typically takes the form of a daylong or overnight visit to the campus. Normally, the institution inviting you for an interview pays your expenses for travel and accommodations. You can expect to meet with several faculty members, as well as others who may be asked to provide feedback about you to the search committee, and to give talks about your research. It will be your task to do the following:

- Convince the department that your work is exciting and that you will be a leader in your field.
- Convince each member of the department that you will be a good colleague.
- Find out if the institution and the department are right for you.

Be prepared for a demanding and exhausting experience. You will be on display at all stages of the visit, from the moment you are picked up at the airport until you are sent on your way again.

Advance preparation. Come well prepared by doing the following before your visit:

- Organize the logistics of your trip, including travel tickets, hotel accommodations, arrangements for pick up, and the schedule of events on interview day. Be conservative about your estimates of travel time: You don't need the added stress of missing a connection and being late.
- Find out about the academic interests of the people you are likely to meet. Read a few of their papers or at least skim the abstracts. Be ready to ask them about their work. You can probably find this information on the department's Web site.

- Learn as much as possible about the institution and the surrounding area. Knowing something about the city or town will give you a starting point for small talk.

Dress code. Dress neatly and in keeping with scientific custom as you know it. Avoid dressing at a level of formality that will make you and your hosts uncomfortable.

Preparing your job talk. During your interview visit, you will be asked to give a "job talk"—a formal presentation on your current research. A job talk generally lasts about an hour, including 10 to 15 minutes for questions. You have probably given this kind of talk before, and you know what works for you, but here are a few guidelines on how to prepare your talk.

First, write out the entire talk, thinking of your audience as you write. Remember, a talk is not presented in the same way as a scientific paper. You must get your main ideas across to listeners who have had little opportunity to study the details, as well as to those whose research interests and backgrounds are very different from yours. You can assume that your audience will be composed of intelligent people who are uninformed about your chosen scientific field. To help your audience follow your talk, divide it into several clear and concise sections, and give an overview of the talk at the beginning. At the end, restate your conclusions and offer an outline of your future research plans. At the outset or at the conclusion of your talk, include a brief statement acknowledging those who helped you in your research.

Next, translate your talk into a slide presentation. Most researchers use PowerPoint presentations to deliver their talks. Remember, however, to bring along a backup disk. Be sure to inform your hosts ahead of time about your audiovisual needs. Try to vary the design of your slides, alternating between text and figures. Resist the temptation to use only bulleted points, but also avoid long sentences. Be sure that your slides are readable and that the order of your slides matches your written presentation. (The American Society for Biochemistry and Molecular Biology and other professional societies publish guidelines for preparing these presentations.)

Finally, practice your talk in front of a mirror. Doing so allows you to time your presentation while getting used to the sound of your own voice. Keep repeating the talk until you can deliver it easily, using your slides as your only memory aid. If necessary, edit the talk down until it can be delivered comfortably within 50 minutes. Remember that a talk that is slightly too short is much better than one that is too long. It may be better to focus on only one aspect of your research, so you can give sufficient detail within the time you have. Save the rest for the question-and-answer session.

When you feel comfortable giving your talk, enlist your adviser, your postdoctoral colleagues, and any graduate students you work with as an audience for a practice talk. Encourage them to ask questions and offer frank criticism. Ask them for suggestions to improve your PowerPoint slides, and leave enough time to edit your slides accordingly.

Delivering the talk. Experienced speakers resort to a variety of techniques to control nervousness. Here are a few of them:

- Arrive early enough to set up equipment and become comfortable with the room. You may have to ask your host to get you to the room with enough time to prepare.

- Plant your feet firmly on the floor. Feeling balanced is important to your self-confidence.
- Know what you intend to do with your hands. A computer mouse and a pointer may be enough to keep you from fidgeting—but be careful not to play with either of them.
- Greet your audience and tell them you are glad to be with them. Make eye contact with a few audience members who seem eager to hear what you have to say. Then plunge in.
- Don't worry if some people nod off or seem uninterested; just continue to give your talk as you practiced it, making eye contact with those who are listening closely.
- Let it show that you are excited about your work. Demonstrate confidence by using "I" wherever it seems appropriate to do so.

> *Some fraction of the audience is always asleep during any talk, no matter how exciting the subject. Find a few people who are listening attentively and give your talk to them.*
>
> —Johannes Walter, Harvard Medical School

Answering questions during a talk can be especially difficult. Several ways for handling this are noted here:

- Repeat the question for the audience. Then take your time answering. If you need to, buy some more time by asking for a restatement of the question. In a pinch, give an interpretation of what you think the questioner wants to know. Then give your best answer and stop. Rambling on only conveys uncertainty.
- If questions are slow in coming, take the initiative by pointing out some aspect of your work that you passed over quickly but that you believe warrants the audience's attention. This gives you a chance to use some of the material you edited out of your talk. You may generate a whole new line of questioning. In case you need to go back through your slides to a particular one in order to clarify a point, arrange to have your computer presentation accessible during the discussion period.
- If challenged, listen to the criticism and give a judicious response. Don't become defensive. If the criticism seems unfair, stand your ground politely. You might suggest a follow-up discussion later.

Giving a chalk talk. During your interview visit, you will likely have an opportunity to give a less formal presentation—a chalk talk—during which you can offer detailed information about the direction of your future research. It should not be a polished slide presentation, but it should be prepared carefully.

Give a brief overview of your research agenda, including your short- and long-term objectives. Then state several specific problems you want to work on, and explain in detail how you plan to proceed. Bring along an overhead or two of preliminary data that will demonstrate the feasibility of your plan. Show that you are familiar with the details of any new techniques you may need to master.

Expect to be interrupted. The chalk talk is a chance to show that you can think on your feet and that you will be an interactive research colleague.

Meeting other faculty members. Typically, part of the interview process will include one-on-one conversations with members of the department. It is important to show interest in their work and ask lots of questions. In addition, assume that you will be taken out to dinner by some of the faculty. This is a chance for them to evaluate you as a future colleague and for you to determine whether you would enjoy working with them. Afterward, they will probably share their impressions of you among themselves.

> *When you're talking to the faculty, it's important to appear interested in everybody's work. You don't have to be an expert on the topic. If you know something about it, it's good to chime in with a suggestion or a question. If you're clueless, it's fine to say, "This is really fascinating, but could you give me a bit more background?" It's also very important to give a dynamite seminar so that the people who didn't get a chance to meet with you privately will have a chance to hear about your work, how you express yourself, and what kind of a context you put your research in.*
>
> —Thomas Cech, HHMI

Meeting with students, postdocs, residents, or other trainees. This is essential for someone who expects to conduct research in any department. A candidate should be concerned if a department doesn't offer ample opportunities (over lunch or in the lab) to meet with students and postdocs in the absence of faculty.

Concluding your visit and following up. Typically, your visit will conclude with a conversation with the chair of the search committee, in which you might expect to learn when a decision will be reached. As soon as you return home, write a formal letter addressed to the chair of the committee, thanking everyone for their hospitality and reiterating your interest in the position. If during your one-on-one interviews, you have promised to share data, be sure to follow up on your commitment. Now it's time to play the waiting game because the committee will undoubtedly be charged with arranging interviews for several candidates.

Be sure to inform the search committee chair if you decide to take another job before the committee extends an offer to you or if for some other reason you decide to withdraw your candidacy.

NEGOTIATING YOUR POSITION

The chair of the search committee or the department chair has given you a tentative offer or at least let you know that you are the top candidate. You are now in a position of maximum strength for obtaining what you want. The search committee has invested time and effort in choosing you, and the last thing its members want is to come up empty or to have to start over. They have decided they want you and will be disappointed if you don't come, and they want you to be happy once you are on board.

Evaluating the Offer

Before making a decision, you will need to find out as much information as possible about the position. If you are not satisfied with some aspects of the offer, try to negotiate better terms. You will have to do the following:

- Learn the details of the offer.
- Reread the list of priorities you made at the outset of your search to evaluate how the job stacks up against that list.
- Calculate precisely what you are worth in salary and other benefits to determine whether the offer measures up. For example, can you afford to live in the community? Does the institution provide housing allowances or low-interest loans to help?
- Enumerate in detail the other resources you believe you need to succeed in your scientific career (decide what is absolutely necessary and what you can live without). In some cases, it may be satisfactory for the department to guarantee you access to shared equipment, rather than buying you your own.
- Make your wishes known to the institution representatives and engage them in the process of negotiating with you.
- Get *everything* spelled out in writing.

> *In theory, everything is negotiable. That said, every department and institution has constraints.*
>
> —Chris M. Golde, from *"Be Honorable and Strategic," Science*'s Next Wave (November 2001)

The search committee is your natural source for basic information about the terms of the appointment and about university-wide benefits and policies. Ask for a copy of the university's faculty handbook and any other personnel policy manuals. Read them over thoroughly, check them against the recommended standards of the American Association of University Professors (AAUP), and prepare a list of questions for the committee.

You may need to do some homework to rule out problems that may not be revealed in response to direct questions or that you simply cannot ask the search committee about. For example, it would be helpful to know whether the department has experienced internal personal conflicts recently, whether the university has financial problems, whether the chair is retiring or stepping down soon, and whether key faculty members are about to leave or retire. You also want to know whether people who have worked in the department have been happy, well supported, and successful. Use the grapevine: Call people you met during your interview visit, and talk with postdocs or others recently affiliated with your potential department and institution. Be discreet, but be straightforward. You don't want to be surprised.

When you are contacted with an offer, you might be asked for a second interview. This time, you will be able to ask more detailed questions about the position. You might also visit the human resources office, talk with key people in your prospective department, and have a preliminary look at available housing. A second interview visit is an excellent time to start the discussion about what you will need in terms of laboratory space, materials and equipment, and staff.

What You Need to Find Out

Here are some of the details that you will need to ask about.

The appointment. You need to know the following:

- Your job title and what it means
- The length of your initial contract
- The terms under which the contract will be renewed

Verify that you are indeed being offered a full-time tenure-track position. For example, several California schools have offered positions that appear to be full time yet are only half time or less than full time as far as a state-sponsored faculty position is concerned. In these cases, a faculty member is expected to rely on other funds for a significant part of salary and other support. You also need to find out about the process for obtaining tenure (see "Planning for Promotion and Tenure," page 20). Research faculty appointments are often

Question: What if I'm offered an appointment to more than one department?

Answer: Insist on clarification in writing of where your "tenure home" will be, what the performance criteria for tenure will be, who will be making the tenure decision, the percentage of your salary paid by each department, where your office will be located, what your teaching responsibilities will be, and who will serve as your mentor. Seek advice from others who have worked in similar situations. For example, one experienced academic scientist cautions against accepting an appointment that is split 50-50 between departments.

> *If you have a dual appointment, it's important to clarify which department will be paying the bulk of your salary, because that department will have the biggest right to your time. For example, if your secondary department wants you to increase your teaching load, you could request that they negotiate with your primary department to reduce the teaching load there in exchange for picking up more of your salary.*
>
> —Milton Datta, Medical College of Wisconsin

"at-will" appointments, offering no tenure protection if, for example, the position is eliminated or grant funding is lost.

The salary. You need to pin down the following:

- The amount of your base pay (this will determine the level of other benefits and future raises).
- Whether the salary is guaranteed, and if so, for how long—in other words, you need to know whether part of your salary and other support must eventually be obtained from research grants or other nondepartmental or institutional sources.
- The department's history of salary increases.
- Whether you will be paid on a 9-month or 12-month basis (if you are paid on a 9-month basis, find out whether your paychecks can be prorated over 12 months).
- If paid on a 9-month basis, does the institution allow you to pay yourself a summer salary from a research grant? Is there an institutional pool of money that will provide a summer salary for a year or two until you can obtain grant funding?
- Your institution's policies on outside consulting, including how much consulting is permitted, what approvals are required, and what limitations apply.

Hard Money Versus Soft Money

"Hard money" refers to any guaranteed funds that you receive from the university where you are employed. When you are offered a faculty position, you typically receive salary and start-up funds—hard money—to cover the costs of starting your laboratory during the first one or two years of your employment. After the start-up period ends, you may continue to receive hard money support for at least a portion of your salary and perhaps for a technician's salary. However, you will also need to obtain grant support (i.e., "soft money") to pay for your research and, at some universities, all or part of your salary as well. Soft money therefore refers to funds that you receive from grants—for which you will most likely have to compete.

Knowing what you are worth. There are many sources of information that you can use to evaluate your starting salary. Salaries differ widely depending on degree, geographical location, type of institution (public versus private), and scientific discipline. To evaluate the salary offered, you need comparative information on starting faculty salaries at the institution offering you the job and in your field elsewhere as well as on costs of living. Try the following resources:

- The AAUP publishes an annual salary survey in the March-April issue of *Academe* (*http://www.aaup.org*).
- The American Chemical Society publishes a detailed annual salary survey, with data broken down by employment sector, geographic region, and professional specialty, in the magazine *Chemical and Engineering News* (*http://pubs.acs.org*).
- The Association of American Medical Colleges publishes an annual salary survey that contains data for professors at U.S. medical schools (*http://www.aamc.org*).

Figure 1.1 gives starting salaries for BWF Career Award recipients who began faculty positions in 2002 and 2003. These individuals had about 42 months of postdoctoral experience at the time they began their appointments.

Figure 1.1. University starting salaries and start-up packages for junior faculty who received Burroughs Welcome Fund Career Awards in Biomedical Sciences (CABS)

Faculty Appointments, 2002–2003*	
Ph.D.s (n = 21)	
Average 12-month salary	$79,190 ($60,000–$100,000)
Median 12-month salary	$80,000
Average start-up package (less salary)	$508,200 ($200,000–$1,075,000)
Median start-up package (less salary)	$470,000
Physician-Scientists (n = 10)	
Average 12-month salary	$119,000 ($93,000–$150,000)
Median 12-month salary	$117,500
Average start-up package (less salary)	$331,500 ($90,00–$600,00)
Median start-up package (less salary)	$336,000

*Data are for CABS awardees who advanced from postdoctoral to faculty positions. The positions ranged across the basic biomedical sciences, public and private institutions, and U.S. geographic areas. Although sample sizes are small, data are consistent with cost-corrected data for the 110 CABS recipients who received faculty positions between 1998 and 2001.

Source: Rolly L. Simpson

Other forms of compensation. Get the details of the following:

- Health coverage, life insurance, disability insurance, and retirement benefits
- Other family-related benefits, such as tuition support for family members and access to university recreational facilities
- Whether moving expenses will be paid
- Availability of a housing subsidy or at least assistance in obtaining housing

Start-up package. Find out what resources the university will make available to support your research until you can obtain grant support. Specifically, ask about office and lab space, equipment, computers and software, a technician and other support staff, the principal investigator's contributions to graduate student stipends, help in obtaining grants, and support for travel to conferences and meetings.

Service within the university. Ask how many committees and other projects you will be expected to become involved with.

Teaching responsibilities. Although rewarding, teaching can be the most time-consuming activity for new faculty. You will want a clear statement about the following:

- Your teaching load (the number of classes each term, typical enrollments, and levels and types of students)
- Teaching-related responsibilities (office hours, direction of student theses, advising students)
- Teaching-related responsibilities if you have an appointment in two different departments or if you will be a member of one or more departmental graduate faculty groups or of an interdepartmental graduate program

Ask for a reduction in teaching responsibilities if your appointment involves heavy service responsibilities or if the position entails an appointment in two departments.

Protected research time. Now is your best chance to maximize and codify in writing how much protected time you will have for research. You need to clarify as much as possible expectations and decrease, if necessary, the number of other obligations you have (also see box "The Challenge for Physician-Scientists," page 25). Remember, your research time is protected to the extent that *you* take steps to protect it. Once you have signed a contract it will be hard to make changes.

> *The issue of protected research time—not the compensation package and lab space—is the single most important negotiating point for junior faculty. If the institution is not willing to specify a time split in writing, you should worry.*
>
> —Todd Golub, HHMI and Dana-Farber Cancer Institute

Getting What You Need and Want

How to negotiate. Present your requests clearly. Give the institution's negotiator a complete list of things you need. Then give the department time to respond. The negotiator must present a coherent proposal to whoever holds the resources you want, so avoid making numerous requests.

When the institution responds and you begin to discuss the terms of employment, be prepared to make trade-offs. Knowing what is essential to you is crucial at this time.

The offer letter. The fruits of your negotiations should be reflected in an official letter from the institution offering you a job. Work with the institution to craft as comprehensive a letter as possible. The letter is usually your contract, so take it seriously. In addition to the basics (e.g., title, salary, and research support), the letter should detail the timing, schedule, process, and requirements for tenure.

> *I tell all of my postdocs who are negotiating for faculty positions: Once you sign on the dotted line, don't count on getting anything you haven't already been promised, no matter how reasonable it might seem.*
>
> —Thomas Cech, HHMI

Handling Multiple Offers

Multiple offers are gratifying, but they make life complicated. The important thing is to deal honorably. The following rules apply:

- Keep all parties informed of the status of your other applications.
- Use your leverage to ask an institution to match an offer but only if you intend to accept the offer.
- Be prompt to refuse, so that other candidates may be considered for a job you don't want. Keep in mind, however, that it can be risky to decline all your other offers before you've accepted your first choice in writing. There have been cases when firm verbal offers have been withdrawn because of a university-wide hiring freeze.
- Ask for an extension of a deadline if you need to, but don't miss a deadline.

> *Memories are long in academia, and dealing badly once will haunt you throughout your career.*
>
> —Chris Golde, Carnegie Foundation for the Advancement of Teaching

Making Your Decision

Discuss all the pros and cons with those you trust. Sleep on your decision. Once you make it, don't look back.

PLANNING FOR PROMOTION AND TENURE

You have accepted the job. In six years' time, your research program must be well under way. You must have solid grant support, several substantial papers published in high-quality peer-reviewed journals, a reputation among your colleagues as a scientist headed for success, a good track record in teaching and advising students and trainees, and relationships within the university that mark you as a desirable colleague.

You are more likely to succeed if you understand from the start how the decision regarding tenure and promotion is made at the institution you are joining. You can then start planning your strategy accordingly.

The Varieties of Tenure-Track Faculty Careers

A tenure-track position is one that leads to a permanent professorial appointment. In most institutions, tenure confers virtual lifetime job security because a tenured professor cannot be fired except for certain limited causes, such as gross misconduct or neglect of duty.

There are several subcategories of tenured professorship. The standard tenured position at a university combines research, teaching, and service to the university and the profession. Clinical professorships in a medical school may include responsibility for patient care in addition to the standard responsibilities.

Time Frame for Progress Along the Tenure Track

The exact time frame for tenure and promotion has been established by your institution. In general, if you are appointed as an assistant professor, you can expect to be considered for advancement within about six years.

Criteria for Tenure

The official criteria for tenure form a "three-legged stool." You will be judged on your research; teaching; and service to the university, your profession, and the public. Whether or not these criteria have been spelled out in detail, the following expectations are typical.

Research. Your research must be of a quality and quantity that contribute substantially to your scientific discipline. Publication in peer-reviewed journals in your specialty and statements from individuals in your field who can testify to the quality of your research are the principal pieces of evidence showing that you meet this standard. Publications in scientific magazines that reach a wider audience give you additional credit. Substantial, ongoing research grant support is required; for example, some institutions require that you have at least one NIH R01 grant. Additional evidence includes prizes and other recognitions of your work as well as invitations to present your work at conferences.

Teaching. You must have evidence that you are a competent teacher and that you fulfill your responsibilities to your students in a conscientious manner. Teaching is notoriously difficult to evaluate, but your department should have mechanisms to do so. Colleagues in your department may be assigned to supervise your teaching and offer guidance. Students' evaluations are another piece of evidence of your competence and rapport with your students. You may also be asked to report on your own teaching activities.

Medical Center Career Tracks

In general, a faculty member in a basic science department in a medical center holds a tenure-track appointment, with responsibilities for research, teaching, and service. Such appointments are regarded as the most desirable and stable types of academic appointments because the institution assumes some obligation for salary and other types of support. However, in some departments, there may be faculty appointments that are not on the tenure track. For these individuals, the primary responsibility is research, with limited responsibilities in teaching and service. In this case, the faculty member may be entirely responsible for raising funds for his or her salary and for all other expenses needed for scientific research. Such appointments are generally given for a limited period, subject to renewal at the discretion of the department chair.

Types of faculty appointments in clinical departments, such as medicine, pediatrics, or pathology, have evolved during the past few years. These are now commonly divided into three types of appointments: (traditional) tenure track, medical-clinical track, and clinician-educator track. The latter two types of appointments generally are not tenure based. Most senior, established faculty in a clinical department will hold tenure-track appointments that include research responsibilities in addition to patient care and teaching. These are regarded as the most desirable because they offer the greatest protected time for research (often 70 percent or more).

Medical-clinical and clinician-educator appointments are being made in increasing numbers. Their main benefit is job flexibility, but it's at the expense of tenure. Clinical departments that provide extensive and high-volume clinical services may appoint faculty to a medical-clinical position that includes both patient care and research in various proportions. Research time is often limited to 30 to 50 percent, and the remaining time is dedicated to clinical service. Typically, the research is expected to be translational in focus, either through administering core laboratories or managing research activities as a component of larger collaborative grants awarded to tenure-track investigators. Advancement is based on research or clinical productivity. If extramural research funding is not available, there is often room to negotiate increases in clinical service work in lieu of research. The clinician-educator track focuses on the teaching of medical students and residents and performing clinical care. As such, there is little expectation of research activity. Salaries and benefits for both medical-clinical and clinician-educator appointments are generally provided by the department through income from clinical services.

Pure research-based nontenured appointments may also be made in clinical departments for faculty who are engaged in basic or clinical research. The expectation is that these individuals will be able to raise their own salary and laboratory support through research grant or contract funding.

Service. You must demonstrate that you are willing to work for the betterment of the university, your profession, and the public at large. Service on departmental and other campus committees, on research ethics boards, on editorial boards of journals, and on grant study sections demonstrates your willingness to assume your share of responsibility. Work for professional associations and work as a consultant to government and industry also count as service.

The weight that will be given to each area by your tenure committee will depend on the mission of your institution and your department. In a premier research department or institution, research is primary, and it is the progress of your particular program that counts the most.

> *You build a research group by being in the lab as much as possible. The assistant professors who don't get tenure are the ones who spend all of their time in the office instead of in the lab.*
>
> —Thomas Cech, HHMI

The Review Process

The review processes for promotion from assistant to associate professor and tenure are intertwined. Tenure review entails a series of yes-or-no decisions by committees established at the department, school, college, and campus or university levels. The decision of the university-wide committee must be ratified by the president or provost of the university and governing board of the institution.

Universities vary as to whether the tenure process is open or closed—that is, whether you and anyone else will have access to the file containing the evidence for tenure and the record of the committees' deliberations. Regardless, a candidate usually has an opportunity to appeal a negative decision.

The process unfolds *roughly* as follows:

- During your second or third year of employment, your department chair creates your promotion and tenure dossier (see below for details about what it should contain).
- Before the end of your third year, the tenured faculty within your department vote on whether to recommend your reappointment for another three years.
- After the vote, your department chair meets with you to discuss any problems that may hinder your future prospects.
- During your fifth and sixth years, letters are solicited from both internal and external experts in your area and comments are solicited from your current and former trainees.
- The tenured faculty in your department review the materials and vote on whether you should receive tenure.
- If the department votes in your favor, your tenure dossier goes forward to the college's or university's appointments and promotions committee. Your department chair goes before this committee to discuss your qualifications.
- If this committee's decision is favorable, the package is sent to a university-level ad hoc or standing committee. The package is then sent to the provost and university president (or chancellor) and then on to the governing board for final approval.

Your Tenure Dossier

You should have the opportunity to contribute to your dossier. It should include the following:

- Your personal and professional history—essentially an extended CV detailing your education; academic positions and other professional employment; honors, prizes, and achievements; invited lectures and conference presentations; offices in professional societies; editorships of journals and other learned publications; grants received; and service on study sections
- A list of your publications and other creative works

> *Nothing is too trivial. If you were recognized in some way, make sure it appears in your dossier.*
>
> —Tony Waldrop, University of North Carolina–Chapel Hill

- A summary of your teaching activities, including courses you have taught, other contributions to the university's instructional program, the results of students' evaluations, and your own report of your teaching activities
- Details about the work and subsequent placement of graduate students supervised
- A description of your internal and external service to the university, your profession, and the public
- A statement of your research goals and accomplishments, expressed so that members of a campuswide tenure and promotion committee can appreciate the importance of your work
- Letters from outside reviewers, who should be leading experts in your field and aware of your work (you may be asked to suggest several of these scientists)

Question: What do I need to do every year to help me attain tenure?

Answer: Update your CV, network with professional colleagues, and keep in close touch with your department chair and your mentors to evaluate your progress. In addition to these ongoing tasks, review your objectives and update them if necessary.

Planning for Tenure: What You Can Do

Set specific, achievable objectives right at the outset of your career, with timelines that tell you what you need to accomplish each year. The whole process will seem more manageable, and you will be able to make realistic career decisions based on your progress.

Designing and Equipping Your New Lab

You probably discussed your space and equipment needs during your interview and the negotiation process. Before you move into your new laboratory, create a detailed plan for how you intend to work within the space allotted to you. This will help you hit the ground running once you start your position. The following is a list of things you should do:

- Envision the relationships between the various workstations, preparation areas, and offices.
- Arrange for and help supervise any renovations.
- Order equipment and supervise its installation.
- Acquire any licenses required by regulatory agencies.
- Put in place data management systems both for control of laboratory ordering and expenditures and for the documentation of your research.

A series of online articles, "The Art of Laboratory Feng Shui," at *Science*'s Next Wave (*http://nextwave.sciencemag.org*), will take you through these decisions. Another resource is a series of videos on laboratory safety, produced by the Howard Hughes Medical Institute and available at no charge from the Institute's online catalog (*http://www.hhmi.org*).

Year 1. You should

- Set up your lab as soon as possible. Try to remodel your lab space, order equipment, and hire technicians before you arrive. If, after you arrive, you encounter problems, you may need to revise your tenure schedule.
- Learn your institution's ground rules for tenure.
- Ask for a faculty mentor if you are not automatically matched with one. You need someone who is effective in helping you wade through department politics and protocol. You may need an unofficial mentor if the official one disappoints you. In this case, be tactful.
- Get to work. If appropriate, write up your postdoctoral research and submit it to a journal.
- Accept committee responsibilities, but avoid becoming bogged down. Think carefully about the workload of any committee you are asked to join. You also need to consider the nature of the work. Some committees may be too politically sensitive to be of much use so early in your career. (See chapter 6, "Time Management.")
- Enter the "grantsmanship" game. You may want to start by applying for small grants ($5,000 to $25,000) from your own institution or from other sources to test the waters as you begin work on your major R01 grant submission.

Year 2. You should

- Try to publish the research you did in your first year.
- Apply to NIH or the National Science Foundation for a basic research grant. (See chapter 9, "Getting Funded.") Ask your mentor and other colleagues to review your proposal.
- Teach with the tenure review process in mind. Have your chair, mentor, and other colleagues observe your teaching. Be sure your students fill out the evaluation forms at the end of each course. You may want to create your own simple essay-type evaluation form for your students as well as the trainees and other personnel who work in your lab. You want their feedback.

Year 3. This is the year the tenured faculty will vote on your reappointment. You should have been meeting regularly with your department chair to discuss your progress, so you should have a tenure file that will support your reappointment.

- Ask if you are on track for tenure. If not, take stock and consider adjusting your career goals at this point. If you are not doing well in a tenure-track position, and if you are a physician and want to stay in academia, this may be the time to think about moving into a research or clinical track.
- Ask your department chair for a checklist of the information to be included in the file.
- If your R01 was not funded, resubmit it and have a plan for backup funding. (See chapter 9, "Getting Funded.")

The Challenge for Physician-Scientists

If you are a physician, you will probably be expected to spend some time in income-generating patient care. Be sure this requirement does not engulf your research time. If you are serious about doing research, you should negotiate a written promise of a fixed percentage of "protected research time." Often, physician-scientists will have 20 to 30 percent of their time for patient care and 70 to 80 percent for research. Make sure you understand the true amount of protected research time you will receive, because your defined clinical time will not include time for teaching or for administrative duties.

There's a positive side to your situation. Your clinical responsibilities give you an advantage at tenure time because they count as an extra dimension of professional achievement.

Years 4, 5, and 6. You should begin to be recognized in your field for your research. The invitations that come your way to participate on panels or to serve on review committees are indications of success. If these opportunities are not occurring, take steps to gain exposure, perhaps by suggesting a session on your subspecialty at a national meeting. (See chapter 10, "Getting Published and Increasing Your Visibility.")

You need to address any issues that may hinder your bid for tenure. If you have not obtained funding, this should be your number one priority. Keep up your research, and continue your efforts to get the results into print.

Clearly, the road to a tenured faculty position is not an easy one. But if you think strategically—know what you want and need from your job, present yourself and your research to best advantage to obtain that job, and do what you should do each year to document your productivity—you will be well on your way to achieving your goal.

RESOURCES

Austin, Jim. "You've Worked Hard to Get This Far." *Science*'s Next Wave (November 22, 2002), http://nextwave.sciencemag.org/cgi/content/full/2002/11/20/3.

Babco, Eleanor L., and Nathan E. Bell. *Salaries of Scientists, Engineers, and Technicians: A Summary of Salary Surveys.* Washington, DC: Commission on Professionals in Science and Technology, 2003, http://www.cpst.org.

Davis, Martha, and Gloria Fry. *Scientific Papers and Presentations.* New York: Academic Press, 1996.

Golde, Chris, M. "After the Offer, Before the Deal: Negotiating a First Academic Job," *Academe: Bulletin of the American Association of University Professors*, January/February 1999, 44–49, http://www.aaup.org/publications/academe/1999/99jf/GOL_JF99.htm.

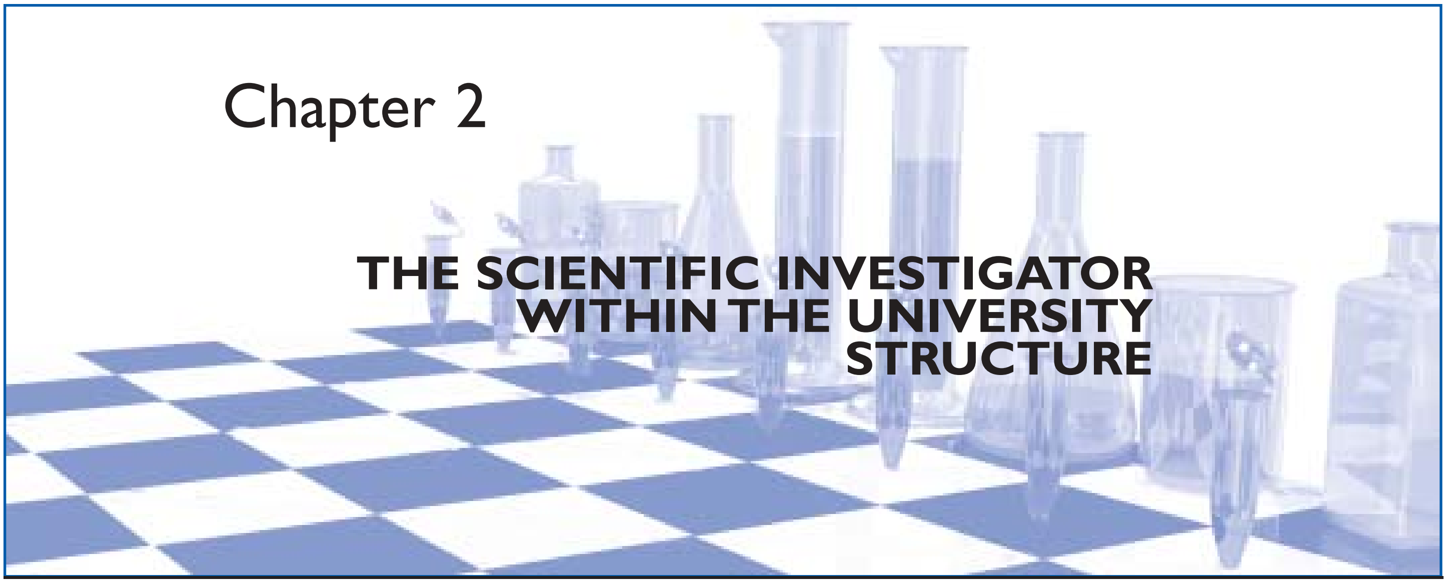
Golde, Chris, M. "Be Honorable and Strategic," *Science*'s Next Wave (August 24, 2001), http://nextwave.sciencemag.org/cgi/content/full/2001/08/22/7.

Heiberger, Mary M., and Julie M. Vick. *The Academic Job Search Handbook*. Philadelphia: University of Pennsylvania Press, 1996.

Reis, Richard M. *Tomorrow's Professor: Preparing for Academic Careers in Science and Engineering*. Piscataway, NJ: IEEE Press, 1997.

Schoenfeld, A. Clay, and Robert Magnan. *Mentor in a Manual: Climbing the Academic Ladder to Tenure*. Madison, WI: Atwood Publishing, 1994.

Whicker, Marcia Lynn, Jennie Jacobs Kronenfeld, and Ruth Ann Strickland. *Getting Tenure*. Survival Skills for Scholars, vol. 8. Thousand Oaks, CA: Sage Publications, 1995.



Chapter 2

THE SCIENTIFIC INVESTIGATOR WITHIN THE UNIVERSITY STRUCTURE

This chapter is based on a keynote presentation by Tony G. Waldrop, Ph.D., University of North Carolina–Chapel Hill, at the BWF-HHMI Course in Scientific Management. Additional information was obtained from W. Emmett Barkley, Ph.D., Howard Hughes Medical Institute (HHMI); Peter J. Bruns, Ph.D., HHMI; R. Alta Charo, J.D., University of Wisconsin Law School; Milton W. Datta, M.D., Medical College of Wisconsin; William R. Galey, Ph.D., HHMI; Carl Rhodes, Ph.D., HHMI; and some of the resources noted in this chapter.

You have no doubt spent many years in academic institutions and are familiar with their overall structure. But now, as a tenure-track faculty member, you are entering into a new set of relationships with your professional colleagues. Perhaps for the first time, you will have to deal with many of the university's administrative offices to fulfill professional responsibilities apart from those associated with your laboratory research.

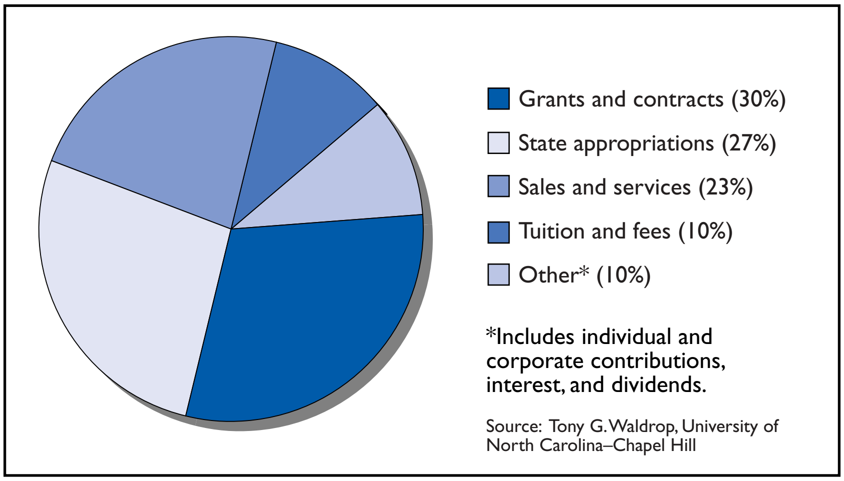
This chapter provides an overview of the "typical" structure of a research university and an academic health center, as well as the resources available to a beginning investigator. It also discusses the professional responsibilities of academic faculty outside the laboratory, including teaching and service and, in the case of physician-scientists, patient care.

ORGANIZATION OF A "TYPICAL" UNIVERSITY

Although the major goal of U.S. universities is the advancement and dissemination of knowledge, universities also need funding to support their activities. A university must seek revenue from a variety of sources (see figure 2.1), and more and more, faculty members are encouraged to generate income. You will need to make your research program either self-supporting or demonstrably worth its cost in some other way.

Most U.S. research universities have *roughly* similar organizational and reporting structures. The titles of the executive officials may vary, but their functions are generally the same. The organization of a university's administrative staff and its methods of operation reflect a strong tradition of faculty dominance.

Figure 2.1. Annual revenue sources at a typical university



University-Wide Responsibility

- Board of trustees or board of regents. The university's highest authority, this governing board is composed of academic, business, and community leaders who hold appointed or elected positions with specific terms. The board meets regularly to review all major policy, financial, and management decisions, including decisions about faculty appointments, promotions, and tenure.
- President or chancellor.[1] The university's chief executive officer, this individual has general oversight of the university's academic programs and financial health. He or she is also the university's public spokesperson, dealing with "big-picture" issues such as relationships with the legislature and other funding bodies, alumni relations, and fund-raising.
- Provost or vice president for academic affairs. As the university's chief academic officer, the provost has programmatic and budgetary oversight over all academic activities. The provost reviews the appointment papers of new faculty members and receives reports from the promotion and tenure committee. The deans of the various colleges report to the provost for academic-related matters. In some universities, vice presidents who are involved with academic affairs (e.g., research, student affairs) also report to the provost.
- Vice president for administration and finance. The university's chief financial officer, this individual is in charge of the fiscal affairs of the university and often also oversees diverse functions such as facilities planning and construction, human resources, and campus services (e.g., parking, public safety, maintenance, and mail service).
- Vice president for research. The university's chief research officer, this individual oversees grants and contracts, research funding, research centers and institutes, issues relating to technology transfer (patenting and licensing), and research-related committees such as Institutional Review Boards (IRBs) for human subjects research and institutional animal care and use committees.

1. For this discussion, "president" is interchangeable with "chancellor." In some state university systems, the president oversees and coordinates the activities of the member universities, and a chancellor heads each university within that system.

Other vice presidents have responsibility for other areas that may affect the life of a faculty scientist directly or indirectly. These include the following:

> ### Consult the Faculty Handbook
>
> Your university's faculty handbook (often available online) is an invaluable resource for learning about the institution's organization and reporting structure, policies and procedures, and resources to support your research.

- Vice president for information technology. This individual oversees the university's computer facilities and telephone systems.
- Vice president for health sciences. This individual is responsible for the university's health-related institutions, including the medical center and the other health professions schools. (See "Organization of a 'Typical' Academic Health Center," page 30.)
- Vice president for student affairs. This individual oversees dormitories, recreational facilities, and other necessities of student life and is concerned with issues of student well-being.
- Vice president for development. This individual manages fund-raising, alumni networks, and university relations.

School- or College-Level Responsibility

- Dean. All department chairs report to the dean, who is responsible for the administration of a school or college. A university may have several schools or colleges. Each college may also have an associate or assistant dean or both.
- Department chair. Each college is likely to have several departments, and in the sciences, separate scientific programs within each department. The dean typically appoints the department chair, with input from the tenured faculty, for a limited time period. Within that time frame, however, the department chair exercises considerable control over the allocation of resources within the department, including space, use of support staff, and purchases of equipment and supplies. The department chair makes teaching assignments and oversees the evaluation of faculty performance. The departmental promotion and tenure committee makes its recommendations to the department chair, who then presents the recommendation to the university-wide promotion and tenure committee.

As a principal investigator, you report to your department chair. If you have an appointment in more than one department, or in a department and in one of the university's separate research centers or institutes, you may have to report to more than one individual. Each department's interest in your efforts should be spelled out in your offer letter. Usually, the reporting relationship is a matter of "following the money"—where your salary comes from is where your reporting responsibilities lie. (See chapter 1, "Obtaining and Negotiating a Faculty Position and Planning for Tenure.")

ORGANIZATION OF A "TYPICAL" ACADEMIC HEALTH CENTER

An academic health center within a university is a complex set of institutions, typically a medical school and hospitals; outpatient centers; and, in many cases, schools of nursing, pharmacy, and other allied health professions. Because much of the teaching conducted under the auspices of the medical school actually takes place in the hospitals and clinics, these organizations should have agreements or understandings in place that allow the faculty to appropriately carry out activities, from teaching to research to the provision of clinical care.

Key academic health center officials include the following:

- Vice president for health sciences. This individual oversees the entire complex and reports to the president of the university.
- Chief executive officer(s) of the hospital(s) and clinics. These individuals are responsible for the day-to-day operations of the hospitals and clinics and report to the vice president for health sciences.

Administrative Structure of the School of Medicine

The administrative structure of a medical school parallels that of the university in many respects. However, one distinctive feature is that the school is composed of clinical and basic science departments.

Medical school officials include the following:

- Dean. The dean's functions are similar to those of the dean of any other university college; the only exception is that he or she may also serve as vice president for health sciences. On administrative matters (e.g., procurement), the dean of the medical school may report to the vice president for health sciences. On academic and faculty matters, the dean reports to the provost. The medical school often also has associate and assistant deans with specific areas of responsibility.
- Department chairs. As elsewhere in the university, the chair is the administrative head of the department.
- Division chiefs. Frequently, large clinical departments in a medical school are grouped into divisions. In such cases, a scientist may be a division chief who, in turn, reports to a department chair.

If your appointment is in a basic science department, you report to the department chair; if your appointment is in a large clinical department, you usually report to the division chief. It is not uncommon for an investigator to hold a primary appointment in a clinical department and a secondary appointment in a basic science department or vice versa. In this case, the investigator reports to the department in which the primary appointment resides.

PEOPLE YOU SHOULD GET TO KNOW

As a beginning investigator, you will want to quickly learn which individuals can affect your career progress. You will want to find out which department chairs and division chiefs should be aware of your work because it is relevant to their own research agendas. You will certainly want to meet the full professors within your own department or division. If you are a clinical investigator, you should also get to know the influential senior physicians; if they like you and appreciate your contributions, they may support your research aspirations.

It's also a good idea to get acquainted with faculty in your own department and in other departments whose research interests are complementary to your own. You may find colleagues with whom a research collaboration is possible. Teaming up with other faculty scientists in a research project of mutual interest can pay all sorts of dividends for you and your laboratory group. These faculty members will have a good understanding of any health and safety risks associated with your research, and they can advise you about the policies of the university and safe procedures for controlling research risks.

You should also be sure to get to know your departmental business manager and the other administrators in your department or division. These individuals are generally very experienced in dealing with matters such as requesting maintenance, purchasing, tracking grant expenditures, and a host of other matters that you will not have time to deal with in detail. Creating an effective working relationship with your departmental administrators will pay off many times over. These individuals will also be valuable in preserving stability when inevitable changes such as the retirement of a chair or division chief take place.

FACULTY GOVERNING BODIES AND COMMITTEES

Faculty Senate

A representative body of faculty members, sometimes called the faculty senate, serves as the principal channel of communication between faculty and university administration. The faculty senate may elect a smaller executive committee to implement its actions. It can make policy recommendations to the university president and appoint faculty to serve on university committees as well as faculty senate committees. The senate weighs in on the appointment of academic officials and on performance reviews of these officials. It meets regularly during the year.

University Committees

The faculty accomplishes its work through an array of standing and ad hoc committees. The names of committees and their mandates vary among universities, but representative types of standing committees include the following:

- Promotion and Tenure. Reviews recommendations for faculty promotion and tenure as well as policies and procedures in these areas.
- Admissions. Establishes admissions requirements.

- Academic Requirements. Establishes grading systems and graduation requirements.
- Curricula. Approves new curricula and reviews existing ones.
- Information Technology. Makes recommendations regarding faculty computing needs and concerns.
- Faculty and Staff Benefits. Makes recommendations on health and life insurance, leave, and retirement.
- Ethics. Establishes guidelines for appropriate conduct of research. Reviews cases of unethical conduct by faculty.
- Human Subjects Research. Establishes policies for the ethical treatment of human research subjects and ensures compliance with federal regulations.
- Long-Range Planning. Develops a long-range plan for the university.
- Research. Establishes policies to promote research and distributes university research funds.
- Radiation, Biological, and Chemical Safety. Establishes procedures to carry out institutional policies for complying with regulations governing the use of hazardous materials in research.
- Use and Care of Animals. Establishes policies for the humane treatment of animals used in research and ensures compliance with federal regulations.

The meeting schedules and workloads of these committees vary considerably. Generally speaking, committees that have responsibility for case-by-case review of individual applications or projects are the most labor-intensive. However, the workload of a policy committee may suddenly expand when it finds itself dealing with a "hot" issue. (Further discussion of a principal investigator's priorities with respect to committee work can be found in the section "Responsibilities Beyond the Laboratory," page 35.)

Departmental committees can include standing committees (such as those responsible for departmental courses and curricula, admission of graduate students, and selection of residents and fellows) as well as committees created in response to a particular need (such as the recruitment of a new faculty member).

SUPPORT FACILITIES AND SERVICES

Universities provide considerable support to aid faculty in their research, teaching, and public service. Support includes traditional campuswide resources such as libraries and media centers, scientific or technical services commonly referred to as "core facilities," and administrative offices established to help faculty complete grant applications and comply with regulatory requirements. As a scientist, you must know what centralized facilities exist to support you.

You are probably already familiar with the traditional campuswide resources and core facilities at your institution but may have never dealt with administrative support services. Listed below are several offices that may prove essential to you as you get your lab off the ground.

Regulatory Compliance Office

Regulatory compliance may be handled by the university-wide office of research or a similar office in your college or by several offices devoted to specific regulatory issues. Regulatory compliance officers keep track of the licenses and approvals you will need to comply with federal and state regulations for research. Visit them early to find out about the following:

- Requirements for radiation safety if you intend to use radioactive materials. You may need to attend a training session. You will need to obtain authorization of the Radiation Safety Committee to procure and possess radioactive materials.
- Requirements for the possession and use of bloodborne pathogens and other infectious materials and for recombinant DNA research. You may have to register your research with the Institutional Biological Safety Committee or have it approve your research.
- Licenses needed for the use of proprietary reagents and materials and approvals for stem cell research.
- Approvals for human subjects research. Your research protocols will need to be reviewed by an IRB. Because these boards typically meet monthly and the review process can be long, find out about the requirements early.
- Requirements for carrying out studies on animals. You will need to have any research protocols that involve animals reviewed and approved by the Institutional Animal Care and Use Committee.
- Requirements for using lasers and chemicals that have a high degree of acute toxicity and for disposing of hazardous chemical waste. Your institution will have specific protocols and practices to follow for using lasers and handling hazardous chemicals.

Environmental Health and Safety Office

Beginning investigators share a responsibility for laboratory safety. It is important that you participate in the health and safety program of your institution by being familiar with the health and safety guidelines that apply to your research. You should make sure the members of your research group know the hazards that may be present in your laboratory, are trained in safe work habits, and know how to deal with any emergency that may arise. Your institution's environmental health and safety office provides services that can help you with this responsibility. The office typically offers safety training programs, technical assistance, regulatory compliance assistance, risk assessments, and services to test the integrity of safety equipment.

Grants and Contracts Office

Staff of this office can tell you about available university financial support and help you apply for it. The grants office is also likely to have a wealth of information about outside funding opportunities. In addition, this office can help you ensure that your grant application is in compliance with university policies and government regulatory requirements and that it has the necessary institutional approvals. The office can also help you prepare your proposed budget and provide information about indirect costs the university will claim. (See "A Bit About Budgets," page 145, in chapter 9, "Getting Funded.")

Sources of Information on Research Ethics and Human Subjects Research

Government Agency Web Sites

Office for Human Research Protections, Department of Health and Human Services (DHHS)
http://ohrp.osophs.dhhs.gov
This office coordinates implementation of federal requirements for the protection of human research subjects and provides staff support to the secretary's Advisory Committee on Human Research Protections.

Office of Research Integrity, Department of Health and Human Services
http://www.ori.dhhs.gov
This office promotes integrity in biomedical and behavioral research supported by the U.S. Public Health Service. It monitors institutional investigations of research conduct and facilitates the responsible conduct of research through educational, preventive, and regulatory activities.

National Institutes of Health Stem Cell Research
http://www.ninds.nih.gov/stemcells
This site includes policies and requirements for research on human stem cells and guidance for investigators and IRBs.

U.S. Food and Drug Administration (FDA): Guidance for Institutional Review Boards and Clinical Investigators, 1998 Update
http://www.fda.gov/oc/ohrt/irbs
This site gives the FDA's current guidance on the protection of human subjects of research.

Private-Sector Web Sites

Association for the Accreditation of Human Research Protection Programs
http://www.aahrpp.org
This association sponsors an accreditation program for institutions that engage in human subjects research.

National Reference Center for Bioethics Literature
http://bioethics.georgetown.edu
The center provides a free reference service to the public, free bioethics database services, a Syllabus Exchange Clearinghouse for educators, annotated bibliographies, and other services to facilitate the study and teaching of bioethics. Staff at the center compile the *Bibliography of Bioethics*, an annual listing of 3,000 to 4,000 citations.

Public Responsibility in Medicine and Research
http://www.primr.org
This organization promotes the consistent application of ethical precepts in both medicine and research.

Responsible Conduct of Research
http://rcr.ucsd.edu
This site is sponsored by the University of California–San Diego and is funded by the National Institutes of Health Office of Research Integrity, the Department of Energy, and the DHHS Office for Human Research Protections. It includes educational materials for research ethics.

Technology Transfer Office

The Bayh-Dole Act of 1980 gives universities the right to elect ownership of the inventions made in the course of federally funded research. Your university has responded to this incentive by establishing a technology transfer office to manage the patenting and licensing process. (See chapter 11, "Understanding Technology Transfer.") Visit the technology transfer office early in your career, keep the staff informed of your research, and let them help you determine whether any discoveries you make are worth licensing for commercial development.

Procurement Office

This office manages purchasing for the university, and you may be required to use it to buy equipment and supplies. The office can negotiate group or bulk discounts. Its staff is familiar with the full range of vendors and products and can help you arrange custom purchases. Staff members are also knowledgeable about regulatory requirements related to the products they buy. They also keep track of payments and receipt of goods, thereby providing a valuable accounting function for your lab.

Human Resources Office

The human resources office can answer your questions about your own employee benefits and can help you function well as a supervisor. Before you hire your first technician or other support staff, visit this office to find out your university's rules and policies concerning employing and terminating staff, on-the-job discrimination, sexual harassment, and performance evaluation of staff. It is very important that you follow these rules and policies, because they involve matters of federal and state law. In addition, find out whether there is a union at your institution and whether any collective-bargaining agreements or union-related rules affect your interactions with university staff or students. (See chapter 4, "Staffing Your Laboratory.")

Public Relations Office

The public relations office keeps the world outside informed of the achievements of the university and its scholars. Its staff maintains contact with the news media and can help you prepare for an interview, translate your findings into "sound bites," and learn how to field questions comfortably.

RESPONSIBILITIES BEYOND THE LABORATORY

Your roles as a faculty member form a triad of research, teaching, and service. As a scientist at a major university, you will focus principally on research. However, teaching and directing the research of students and postdocs will also be important and gratifying aspects of your activities. Your service responsibility to the university will occur mostly through service on committees. This, too, can be personally and professionally rewarding. If you are a physician, you may also serve the university through your patient-care activities.

Teaching

As a new faculty member, you may find juggling your teaching and research responsibilities to be a bit overwhelming at first. It's a good idea to remind yourself of the value of what you are doing—conveying knowledge and an appreciation of science to young

Resources: How to Teach

Brinkley, Alan, et al. *The Chicago Handbook for Teachers: A Practical Guide to the College Classroom*. Chicago: University of Chicago Press, 1999.

McKeachie, Wilbert J., et al. *McKeachie's Teaching Tips: Strategies, Research, and Theory for College and University Teachers*. 11th ed. Boston: Houghton Mifflin, 2002.

people and possibly inspiring some of your students to pursue their own science careers.

To have time to get your laboratory operations under way, you may wish to negotiate a lighter teaching load during your first year as a faculty member. Other circumstances may also make it necessary to reduce your teaching load, for example, if your department has given you a heavy responsibility in another area or if you have family or personal problems. Talk to your department head about the options that may be available to you.

No matter when your teaching duties begin, take the time to prepare for them. Work up your lectures, take any "how to teach" courses that are offered on campus, and, if you can, sit in on your colleagues' lectures.

Also bear in mind that teaching gives you an opportunity to meet students who in the long run may be interested in research in your laboratory. At many schools, younger faculty members often vie with senior faculty for the opportunity to teach courses to "undeclared" graduate students. Learning how to teach effectively means that you may have more opportunities to interact with undergraduate or graduate students in your department and in others. (For a discussion of balancing teaching and research responsibilities, see chapter 6, "Time Management.")

> *At the same time I was building my research group, I was also teaching. It took about 10 years before I found real joy in teaching. But even in the very early years, I noticed that teaching was a tremendous stabilizing feature for my life—very unlike research, which can be discouraging. With research, there are times when you feel as though you've lost ground and you know less than you did the week before. Whereas teaching is much more steady—you put in a certain number of hours of work and something good comes of it. So, I think the combination of a teaching and a research career is a nice one in that teaching can fill out the dips that are the normal part of doing research.*
>
> —Thomas Cech, HHMI

Committee Work

You will be expected to participate in one or more committees, and your contributions will be evaluated as a component of your service requirement for tenure. Although you should take this responsibility seriously, you also need to be judicious in your choice of assignments. Some committees—especially those that review individual research protocols or applications (e.g., IRBs for human subjects research or admissions committees)—are very labor-intensive. Others may deal with politically sensitive matters that may be difficult for a new professor. For example, you might not want to be on a curriculum committee if a controversial restructuring is under way and your department has a stake in the outcome. Such an assignment would be best left to a more senior colleague.

> *At the assistant professor level, you are expected to be setting up your research program and keeping your head down. Being on a high-profile committee can bring you quick visibility, but it can also make you powerful enemies.*
>
> —Milton Datta, Medical College of Wisconsin

Other committees may deal with matters irrelevant to your concerns as a scientist. So, before you accept a committee assignment, ask for a detailed description of what will be expected of you in terms of time commitment and the nature of the decisions to be made.

Resource: Committee Work

Smelser, Neil. *Effective Committee Service.* Thousand Oaks, CA: Sage Publications, 1993. Part of the series Survival Skills for Scholars (*http://www.sagepub.com*).

Many committees, however, do give you a decent return on your time investment. Serving on a faculty search committee may give you a voice in deciding who a new colleague will be. You might also want to be on a committee that puts together a seminar program or scientific meeting. This will give you a chance to invite your former colleagues, leaders in your field, and new people with whom you may want to network. Work on an admissions committee for graduate students might be worthwhile because it will introduce you to graduate students who could work in your lab. However, work on committees responsible for the admission of medical students can be intensive and time-consuming, and the chances of significant future interactions with medical students (except M.D./Ph.D. students) are less.

A good strategy is to try to get on a committee where your expertise will be useful but where you will not be overburdened. Many department chairs are interested in having junior faculty (especially women or members of groups underrepresented in science) serve on committees, and they can help you evaluate opportunities to add to your committee portfolio.

SPECIAL CHALLENGES FOR PHYSICIAN-SCIENTISTS

Research in clinical settings presents special challenges. Some of them are discussed here.

> *On the clinical side, it comes down to billable time—the clinical hours you work. The physician-scientist must find a department chair who's supportive of his research and communicates this to others in the department and institution.*
>
> —Milton Datta, Medical College of Wisconsin

Straddling the Worlds of Research and Patient Care

As a physician-scientist, you can be active in defining your role by pointing out the value you bring to the department beyond billable hours, such as a scientific perspective on patient care and important training and mentorship opportunities for students and residents. In fact, the federal funding agencies consider physician-scientists to be crucial to the translational science involved in moving from the map of the human genome to strategies for diagnosis and treatment of disease.

You can increase your visibility and security by doing the following:

- Creating allies who will stand up and protect you. Cultivate a few people in your field who think you're terrific.
- Making yourself essential by providing an important clinical skill or filling a crucial clinical need. Other clinicians who know your worth can become your advocates and help protect your interests. Advocates need not be in your own department, but they should rely on you and your expertise.
- Getting the word out that you're doing something. Actively communicate progress on your research with people who matter in your department or division.

Complying with Guidelines for Human Subjects Protection

If your research makes use of human subjects, you must meet the requirements of the IRB with respect to protection of patients' rights and well-being. Your research must be designed to be compatible with the IRB guidelines. In addition, you must obtain and document patient consent, comply with rules for protecting the privacy of patient information, and obtain the IRB's approval before you begin your research.

You may be required to maintain data on your research processes and outcomes for the IRB's inspection. All of this may slow your progress, but failure to comply can shut down your research program. Because obtaining IRB approval can take a long time, find out whether it is possible to apply before you begin your faculty appointment.

THE SCIENTIFIC INVESTIGATOR AND THE OUTSIDE WORLD

As a university-based scientist, you owe allegiance to several constituencies: to the university that supports you, to your profession, and to the general public that stands to benefit from your research. It is absolutely necessary, and possible, to keep these loyalties in harmony.

To keep your outside activities appropriate, you need to be aware of the university's rules and expectations with regard to

- Service in professional associations
- Conflict of interest and conflict of commitment, including limits on consulting activities
- Relationships with the news media and with government and political agencies

Consulting

As your career develops, you may find opportunities to consult with commercial entities such as biotechnology and pharmaceutical companies. Both you and your home institution stand to benefit from relationships that extend your reputation, add to your knowledge and skills, and may result in practical applications of your discoveries. In addition, you may welcome the added income. Remember, however, that the university, as your employer, has primary claim on your labor and allegiance.

Many universities have developed explicit guidelines limiting the extent of a faculty member's work with other parties. It is critical that you know your institution's policies regarding your work outside the scope of university employment and your relationships with outside parties. Your institution should have a clear set of guidelines for these types of activities, and you may be required to report on them regularly. (Additional information on consulting can be found in chapter 11, "Understanding Technology Transfer.")

Public Service

An academic appointment carries with it a public service obligation. As your career progresses, you may be called on to participate on commissions or testify before government bodies on the meaning of your work or on its ethical or public policy implications.

Treat these invitations as a serious responsibility and, as you would with contacts with the press, stay close to the university public relations office. Remember, anything you say in public will reflect on your institution. It is easy to be misunderstood or quoted out of context.

You may also have opportunities to participate in public education—at science fairs, high school assemblies, or other community events. These opportunities can be both enjoyable and rewarding.

RESOURCES

Barker, Kathy. *At the Bench: A Laboratory Navigator.* Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press, 1998.

Boice, Robert. *Advice for New Faculty Members:* Nihil Nimus. Boston: Allyn and Bacon, 2000.

Deneef, A. Leigh, and Craufurd D. Goodwin, eds. *The Academic's Handbook.* 2nd ed. Durham, NC: Duke University Press, 1995.

Goldsmith, John A., John Komlos, and Penny Schine Gold. *The Chicago Guide to Your Academic Career: A Portable Mentor for Scholars from Graduate School Through Tenure*. Chicago: University of Chicago Press, 2001.

Kennedy, Donald. *Academic Duty.* Cambridge, MA: Harvard University Press, 1997.

Menges, Robert J., and associates. *Faculty in New Jobs: A Guide to Settling In, Becoming Established, and Building Institutional Support*. San Francisco: Jossey-Bass, 1999.

National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. Committee on Science, Engineering, and Public Policy. *On Being a Scientist: Responsible Conduct in Research*. 2nd ed. Washington, DC: National Academy Press, 1995.

Reis, Richard M. *Tomorrow's Professor: Preparing for Academic Careers in Science and Engineering*. New York: IEEE Press, 1997.

Chapter 3

DEFINING AND IMPLEMENTING YOUR MISSION

A workshop on laboratory leadership was conducted during the BWF-HHMI Course in Scientific Management. It consisted of theoretical presentations, with examples extracted from interviews with model laboratory leaders, and interactive exercises. The workshop was organized by Martin Ionescu-Pioggia, Ph.D., Burroughs Wellcome Fund. It was developed and led by Christine Harris, Ed.D., executive coach and management consultant, and Joan C. King, Ph.D., Tufts University School of Medicine, and principal, Beyond Success. The information in this chapter is based on interviews by Dr. Harris and Dr. King with the following six model lab leaders: Gail H. Cassell, Ph.D., Eli Lilly and Company; Thomas R. Cech, Ph.D., Howard Hughes Medical Institute; Tamara L. Doering, M.D., Ph.D., Washington University School of Medicine; B. Brett Finlay, Ph.D., University of British Columbia; Charles E. Murry, M.D., Ph.D., University of Washington School of Medicine; and Suzanne Pfeffer, Ph.D., Stanford University School of Medicine. Additional information was obtained from some of the resources in this chapter. Copyright restrictions prevent the inclusion in this manual of the theoretical content and materials presented in the workshop.

As a principal investigator, you are responsible for taking charge of all the practical aspects of managing a laboratory, such as hiring staff, obtaining funding, writing papers, and developing processes to track data and projects. These topics are discussed in subsequent chapters in this manual.

In addition to being a manager, you are also the leader of your lab—guiding your staff toward a shared mission of what you want the lab to achieve and motivating each person to make that mission a reality. This chapter discusses some of the elements of lab leadership—defining your lab's mission and goals, setting expectations for yourself and the people in your lab, and communicating those expectations effectively.

CRAFTING A MISSION STATEMENT FOR THE LAB

The first requirement for guiding the people in your lab is to motivate them with the big picture of your vision for the lab and to articulate goals that will lead to achieving that vision. In her book *At the Helm: A Laboratory Navigator*, Kathy Barker advises writing down a few sentences that summarize the mission or the goals for your lab. This mission statement describes the kind of research you want to do, the motivation for your research, and the kind of atmosphere in which you want to work.

Keep in mind the following points:

- Decide what values you want for your lab (e.g., scientific excellence, discipline, teamwork, competition) and then craft a mission statement that reflects these values.

> *What are my values? I want to do really good rigorous science and I want to publish that work in respected places. I am also excited about the topic we work on, that it is a disease-causing organism and that we have the overall goal of trying to cure this disease. It is really important to me that lab members learn and advance their careers—that people enjoy what they do and take it seriously, work hard, and are good lab citizens.*
>
> —Tamara Doering, Washington University School of Medicine
>
> *Our mission here is to train students and postdoctoral fellows to be outstanding scientists. Although our success as faculty members depends on our discoveries and our papers, you are going to be the most successful if you focus on helping your lab members develop their full potential.*
>
> —Suzanne Pfeffer, Stanford University School of Medicine
>
> *If I were asked to summarize my vision for my lab, it would be respect for each individual's expertise and contribution, emphasis on integrity and accurate record keeping and reporting of results, and being a good team player.*
>
> —Gail Cassell, Eli Lilly and Company

- When developing your mission statement, consider not only your scientific life but also your social and financial goals.
- Craft a statement that you feel comfortable communicating to your peers, superiors, and lab members.

Once you have a mission statement that embodies your aspirations, you can start to plan the steps to get there. Kathy Barker suggests developing a five-year plan that takes into account your career goals (e.g., do you want to achieve tenure in five years?), your scientific goals (e.g., do you want to enter a more competitive area of research?), your social goals (e.g., do you want to start a family?), your financial goals (e.g., do you want to perform some consulting to supplement your salary?), and the lab culture you are after.

The last point is perhaps the most complex. Lab culture refers to a system of informal rules that spell out how people in the lab should behave. You should ask yourself these questions:

- How much time do I want to spend at the bench?
- Do I want a big or small lab?
- How friendly do I want to be with people in the lab?
- What kind of atmosphere do I want in the lab?

> *My vision is that we are going to regenerate the heart after a heart attack. This is really what I would like to accomplish with my career. Initially, I was worried that I would sound "sappy" in some fashion when I told people that I had a vision. I found that at first people may think it's a little odd, but pretty soon when they hear it again and again, you start seeing people nodding their heads and agreeing with you. Having a clearly stated vision does help to inspire in people the mission behind what you are working on.*
>
> —Charles Murry, University of Washington School of Medicine
>
> *Starting your own lab is a lot like getting your driver's license: It's an exhilarating time. Now you have the freedom to go where you want to go and go as fast as you want to go. On the other hand, you have to pay for the gas. You're not just a passenger anymore—you have responsibilities.*
>
> —Thomas Cech, HHMI

Take a few moments to think about the kind of lab described in your mission statement. Every decision you make from now on—from hiring staff to choosing scientific projects for the people in the lab to establishing how communication flows—should be made with this statement in mind.

SETTING EXPECTATIONS FOR YOURSELF

After you develop your mission statement, the next step is to understand your responsibilities as the leader of your lab and set your expectations for yourself accordingly.

Your Responsibilities as a Lab Leader

A principal investigator has five key leadership responsibilities: Setting the general scientific direction for the lab, keeping each person motivated, resolving conflicts, setting and communicating expectations, and mentoring and training the next generation of scientists. (The role of the lab leader in mentoring is discussed in chapter 5, "Mentoring and Being Mentored.")

Setting the general scientific direction for the lab. As the principal investigator, your role is to ensure that research projects are in alignment with your vision for the lab. You need to determine what the lab should work on and what directions the work should take. Work with your lab members to develop specific scientific goals for each of them. You should support people in developing projects that match their abilities and aspirations. You are also the one who needs to determine when it is time to terminate a project.

> *My role is setting the general direction and motivating people. I'm in charge of making sure that the lab runs as smoothly as it reasonably can in terms of ensuring that there's money and support staff, and then steering the lab.*
>
> —Charles Murry, University of Washington School of Medicine
>
> *I decide the area in which we're going to work, but I let others have input into where within that area we should go. For example, at our lab retreat, I tell everyone not to talk about what they've done but instead to talk about where their projects are going to be in six months, a year, two years. When we plan general lab strategy, we ask the questions Where in the field should we be heading? What kind of people or expertise should we be recruiting? I direct the discussion and have the ultimate veto power, but I find people are much more motivated if they feel that they've had input into where the lab is going. It is also very good training for them because eventually, if they become PIs, they're going to have to decide these kinds of things themselves.*
>
> —B. Brett Finlay, University of British Columbia

> *I think the mistake a lot of us make is to assume all too often that individuals don't have any contribution to make, just simply because it might be a minor contribution. I think gaining an appreciation of what everyone brings to the table is extremely important.*
>
> —Gail Cassell, Eli Lilly and Company
>
> *When people present a really good result at a lab meeting, I'll say, "That seems like a pizza result," and I'll buy pizza for the lab in their honor. Sometimes it's by way of appreciation rather than an important result. If someone—say a junior technician—gets stuck in a cloning project for a long time and then gets the construct he's been trying to make, that's a pizza result.*
>
> —Tamara Doering, Washington University School of Medicine

Keeping each person motivated. One of your key roles is to motivate people to work hard toward achieving your shared vision. While different people respond to different types of internal and external motivation, most people are motivated when their contributions to the laboratory are recognized and appreciated. This can be accomplished by involving them in discussions about general scientific strategy, listening to their ideas, and giving serious thought to anything they say even if it seems a little impractical or naive.

Another good way to keep lab members motivated is to schedule individual meetings as often as once a week. Each meeting can also serve the purpose of setting deadlines, discussing completed or in-progress experiments, solving problems, and planning future experiments.

> *I do half-hour meetings with each person once a week. If they come in and say, "Nothing worked," I say, "OK," and change the subject because I realize that probably 90 percent of the experiments as a scientist don't work. I've found that this approach is a very subtle but effective motivator. Most people don't want to come into my office week after week and say, "Nothing worked."*
>
> —B. Brett Finlay, University of British Columbia

It is important to listen to what each person wants to do and understand what his or her goals may be. If a postdoc has decided to pursue a career in industry, trying to motivate him or her to follow in your footsteps into academia will not work. As a lab leader, you need to simultaneously address your lab members' individual goals while working together to realize your shared vision.

> *It's important to me that people get the training that they want and have their career going the way they want it, rather than go by any preconceived notions I have.*
>
> —Tamara Doering, Washington University School of Medicine

Finally, enthusiasm is a great motivator. If the work you are doing may someday save human lives, talk about this vision to your lab members—share your enthusiasm. Soon they will follow your lead.

> *I wanted to be in science and medicine since I was a kid. I could not imagine a profession that fits me better. It is useful to let people know I am doing what I always wanted. Things trickle down from that.*
>
> —Charles Murry, University of Washington School of Medicine

Recognizing low morale. A lack of motivation may manifest itself as a decrease in productivity. For example, someone who was productive will stop producing results consistently week after week. You will first need to determine the cause for this decrease. Is it an interpersonal problem in the lab, an experimental obstacle, or a personal crisis? Discuss the problem with the lab member and see whether you can jointly develop a strategy to address the issue or minimize the impact of the lab member's actions. Whatever you do, do not avoid the problem.

Resolving conflicts. Don't ignore conflict in the lab in the hope that it will disappear on its own. Deal with conflict as soon as you become aware of it. If you let a problem fester, it can adversely affect lab morale and productivity. Take the time to meet with each person individually and hear all sides of the story before doing anything. Then bring together all the people involved for an open discussion, which you as the lab leader should moderate. The desired outcome is a mutually agreeable strategy that will resolve the conflict.

Conflicts often arise over "turf wars," when two individuals are interested in the same project. By staying on top of what each member of your lab is doing, you can often spot potential problems and deal with them before they become too serious. For example, if you perceive that two projects in the lab are starting to merge or overlap, call a strategy meeting and re-prioritize the activities for each person involved in the projects.

Setting and communicating expectations. Expectations for each member of your lab will stem from your mission statement and should include scientific, personal, and ethical considerations. Your lab members need to understand your expectations and consent to fulfill them. If you value teamwork, you will stress collaborative and collegial interactions among lab members. If you value primacy in your field above all else, you will probably expect long hours of work and high productivity. This aspect of lab leadership is discussed more in "Setting Expectations and Communicating Them to Others," page 48.

Developing a Leadership Style That Suits Your Personality

The expectations you set for yourself will be based, in part, on your personal leadership style. Developing your style as a leader is a process of trial and error and may prove difficult at first. It will be shaped by your vision for your lab as well as by your personal strengths and weaknesses. It will also be shaped by your past experiences—good and bad—in other labs. As new people join your lab, you may find that different dimensions of your style emerge.

> *When you begin a lab, difficult issues are going to arise, and you'll talk to your colleagues and ask them for guidance. You will try different approaches and see what works. It's very challenging, but it does get easier with time.*
>
> —Suzanne Pfeffer, Stanford University School of Medicine

Assess Your Strengths and Weaknesses

According to Denise Harmening in her book *Laboratory Management: Principles and Processes*, the attributes of a good lab leader are

- *Character:* Having authenticity and purpose; creating value, trust, and compassion.
- *Integrity:* Possessing sincerity and honesty.
- *Vision:* Being able to see the big picture.
- *Passion:* Having great enthusiasm for the job.
- *Credibility:* Having excellent credentials, substantive knowledge, and practical experience.
- *Empowerment:* Being able to delegate responsibility to others when possible.

- *Courage:* Being able to create a new vision and take risks.
- *Insight:* Having the ability to understand people and the organization.
- *Humility:* Being willing to admit that others have good ideas and accepting that you can be wrong.
- *Sense of humor.*
- *Emotional intelligence:* Having self-awareness, social awareness, and social skills.
- *Positive self-esteem:* Being able to work selflessly to support people in your lab.

Think about which of these attributes you possess and work with them. You may develop new skills as you gain experience, but initially, you should rely on your strengths.

SETTING EXPECTATIONS AND COMMUNICATING THEM TO OTHERS

A key aspect of your role as a lab leader is to set and effectively convey expectations that reflect your vision for the lab. Some expectations may apply to a particular group of lab members (e.g., postdocs), and others will be unique to each individual. You may want to work with your lab members to set these expectations—this can increase the likelihood of buy-in and help increase motivation. Below are some general areas that you will want to consider when setting expectations for people in your lab.

Work Hours

Generally, your work hours set the pace in the lab. The members of your lab are watching to see how hard you work and the number of hours you put in. So, if you don't come back to the lab or work from home at night, you shouldn't expect people in your lab to work at night. If you never show up in the lab on weekends, you shouldn't expect them to be there.

Question: How do I avoid potential misunderstandings among lab members regarding work hours and time off?

Answer: The best way to handle this is to convey your expectations about work hours and time off to applicants during the interview. For example, the amount of vacation leave varies from country to country (e.g., it is usually longer in Europe than in the United States), so you should let applicants know about your institution's policies.

Many principal investigators may feel they should stipulate a specific number of hours per week that they expect grad students or postdocs to work. But that strategy does not necessarily work well and can generate resentment.

Focusing on productivity will prove more successful than focusing on the number of hours or on the specific hours an individual works. Nevertheless, you will probably want your lab members to be in the lab during certain hours—to make sure that they can interact with you and the other lab members. Should this be the case, make sure you explain your rationale.

> *Some labs get a bad reputation when PIs say, "We expect you to be here every Saturday and never take vacations" or something similar. I think what you want to do is set an example and help your people find how to be most effective. It is possible to work regular hours, but one has to be very organized about it. I have had very efficient people who can be very productive working nine to five and just use their time well. I have also had other people who don't use their time well, and so I try to work with each lab member to help them figure out what works best.*
>
> —Suzanne Pfeffer, Stanford University School of Medicine

Prolonged Absences

Communicate your expectation that lab members should give you several weeks' notice about an upcoming vacation. Inform them of the vacation and personal leave limits at your institution. Your institution will also have guidelines about maternity and paternity leave. It is best to follow these guidelines rigorously.

Authorship of Papers

The inclusion and order of authors on a paper is often a source of discord. In deciding who should be an author on a paper, the principal investigator has to consider who has contributed to what aspect of the work. All lab members who are involved in a particular project should express their expectations concerning authorship credits on the resulting paper and provide their rationale for being considered as an author.

> *I have included a student on a paper because he had a conceptual contribution without which the whole study could not have been done. There was no question, everybody wanted this person on the paper—so an author doesn't have to contribute an actual figure if they've contributed something that was essential for that project to go forward.*
>
> —Suzanne Pfeffer, Stanford University School of Medicine

Here are some guidelines to consider:

- The first author is normally the individual who is primarily responsible for the project. Occasionally, two individuals may share that responsibility. Most journals permit a statement that indicates that the first two or three authors listed have each contributed equally to the publication.

- It is unwise to make up-front promises about authorship. You may choose to make it a policy in your lab to wait until you know how much each person has actually contributed before authorship is assigned.
- In deciding whether to include someone as an author, ask, "Could this project have been done without this person's conceptual or technical contribution?"

Scientific Ethics

The best way to communicate ethics to your lab is to live by those ethics. You may also want to talk about some important ethical issues (e.g., scientific rigor and reproducible and discrepant results) in a lab meeting or in a more informal setting. Many universities offer lectures or seminars in scientific ethics, and you should encourage your staff to attend. An introduction to the ethical conduct of research is a report from the Institute of Medicine, *Integrity in Scientific Research: Creating an Environment that Promotes Responsible Conduct*, which is available from National Academies Press at http://www.nap.edu.

Staying Within Budget

Developing a budget for the lab and staying within the budget is something for which you, as a principal investigator, will ultimately be responsible. But it's a good idea to remind lab members that the amount of funds available to your lab is limited and to teach them to be careful when ordering supplies. In addition, involving your postdocs in budgeting will help them prepare for their future roles as principal investigators. (Also see "A Bit About Budgets," page 145 in chapter 9, "Getting Funded.")

> *I give a "state of the lab" talk once a year. I start with reviewing the accomplishments, the things that have gone well over the last year. I try to point out things that everyone has done so that there is a sense that everyone has been recognized for their part. Then I go over the lab budget—what our "burn rate" is, where our money is coming from—and talk a little bit about money management issues and strategies.*
>
> —Charles Murry, University of Washington School of Medicine

Project Ownership

The principal investigator, with input from individual members, usually decides what projects people in the lab work on. Some labs have strategy discussions every three to four months during which everyone talks about what projects they would like to continue or initiate.

Work in the lab is most effective and productive when members have clearly defined projects that are sufficiently distinct so that each person can carry out some independent work, and at the same time the projects are interrelated so that no one is working in a vacuum. This way, everyone in the lab can consult with and motivate each other. Below are some guidelines:

- Encourage collaboration. You should conduct regular discussions to make sure everyone knows what their individual goals are and to determine how people can help each other make the best progress. An added benefit of a collaborative lab is the increased exchange of information and skills among lab members.

> *I often encourage people to collaborate or help each other with techniques. So if someone has an idea, I'll say, "Why don't you go to so and so, she has been thinking about that or knows how to use that machine. Why don't you talk to her?" And I try to make it reciprocal as much as I can.*
>
> —Tamara Doering, Washington University School of Medicine

- Allow for independent work styles. Working separately may be a necessity for some people at some stages of their scientific development and in the long run will enable aspiring scientists to begin to think for themselves.
- Discourage competition in the lab. There is enough competition in the world of science outside your lab; encourage your group to think of themselves as members of a team. You want people to be comfortable sharing ideas and helping one another.

> *Competition happens all the time. I will tell the more aggressive person that I appreciate that they are very ambitious and that they want to be successful but that they are really edging over onto someone else's territory. I'll say, "Don't you have so many projects of your own? You should stay away from this person's project." Or I'll try to let them know that they are perceived in the laboratory as being aggressive and ask them, "Do you really want that reputation?" To the person who is being encroached upon—these are rarely competitions between equals—I'll say, "I've really been impressed by the way you've put up with this; I think you've handled this very professionally. I know that it's been tough, but I've talked with the other person and I hope things will get better. If they don't, I'd like you to come talk with me and I'll give it another round." I also point out to people that ambition is not all that bad. It is one of the characteristics of a successful scientist.*
>
> —B. Brett Finlay, University of British Columbia

Policy on Letting Projects Leave the Lab

You should develop a clear policy concerning whether or not you will allow postdocs to take their projects with them when they leave your lab. Communicate this policy to all prospective postdocs. Some principal investigators let their postdocs take whatever they had worked on during their stay in their labs, with no strings attached. Others will let postdocs take their projects or some aspects of them to serve as the focus for their new labs. In these cases, the principal investigator makes sure that he or she does not compete directly with the former postdoc's project for a few years, until the postdoc's lab is well established.

> *I personally think it's unfair to say to someone who has slaved away in your lab for three years and goes looking for a job, "You can't continue what you've been working on," because then that person won't be able to get a grant.*
>
> —B. Brett Finlay, University of British Columbia

When you develop your policy, think about how you would want to handle a situation in which the research results are different from what you anticipated or a situation in which the results lead to interesting new avenues of research.

If you have a small research group and a focused area of research, you may not be able to let departing postdocs take their projects with them. In this case, you might have to develop some alternatives to benefit them. One possibility is to give your postdocs six months of salary and resources to generate preliminary data for a new research question or direction.

> *The head of a lab needs to be generous, and that is hard for junior PIs because you feel like you are just starting and everything is crucial to the success of your research program. So it's hard to let postdocs take projects with them. But they need to, and the main thing is to communicate about it.*
>
> —Tamara Doering, Washington University School of Medicine

Communicating Expectations Effectively

The best way to communicate expectations is to convey them continually—at the first interview, on the first day on the job, at lunch time, during lab meetings, and, most importantly, by setting an example. It's also a good idea to communicate your expectations in writing, especially for new lab members and when conducting staff reviews, and to periodically review them with your staff.

> *We have a package that we give people on arrival that tells them what their lab duties are and how the lab is run. The faster you can get new lab members to the bench and get them going, the better it will be.*
>
> —B. Brett Finlay, University of British Columbia

Set an Example

As a general rule, you should live by the expectations you set for your lab members. Show your workers that you enjoy what you are doing. Especially in the early years, be present in the lab, working side by side with them. They will be able to see how you work and what is important to you.

> *There's a strong correlation between a new investigator's ongoing presence in the lab and success, promotion, and tenure.*
>
> —Thomas Cech, HHMI
>
> *They don't just walk in the door and I say to them, "OK, here are my values." You have to lead by example, be honest. Integrity has to start at square one.*
>
> —B. Brett Finlay, University of British Columbia

Lab Meetings

Regular, formal lab meetings are an organized way to ensure that everyone is kept informed of the lab's activities and results and for you to reiterate your expectations and values. By all means, hold regular goal-setting and evaluation sessions: an annual lab retreat, periodic lab meetings involving the full staff, weekly or more frequent small-group meetings to discuss specific issues, and regularly scheduled one-on-one advisory meetings and performance evaluations. More importantly, make sure that the informal lines of communication are always open. Talk to people in your lab on a daily basis—they should not have to make an appointment to see and talk to you. Informal group activities, held periodically, are also important for building morale and encouraging lab members to think of themselves as part of a team.

Research group meetings. Many research groups hold weekly meetings. One or more people in the lab take turns presenting what they've done since they gave their last presentations. They give an introduction, share their results and their interpretation, and then discuss what they plan to do next. Comments and suggestions from the research team usually follow. In some labs, especially larger ones, a research group meeting is a semiformal presentation with overheads or PowerPoint slides and can be a somewhat intimidating experience, especially for a graduate student. In smaller labs, these meetings may be more informal—for example, each person discusses what he or she did that week. These meetings are much more interactive. Yet even in smaller labs, it's important to schedule occasional formal presentations so that students and postdocs can hone their ability to speak about their research.

> *If a principal investigator has 20 people in the lab and you ask the PI at any moment, "What is person number 17 doing?" he or she should be able to give you a two-hour talk on this without any preparation. The sine qua non for being a good lab director is having all of this in your head.*
>
> —Thomas Cech, HHMI

One-on-one meetings. Regardless of the frequency of research group meetings, you should meet often with each lab member to keep current with progress and problems. Invite your students, postdocs, and technicians to come into your office with their lab notebooks and show you what they've been working on. Many principal investigators meet with lab members for an hour each week. They may meet with them more frequently immediately after lab members have finished a series of experiments or when they notice that a lab member is struggling.

Small-group meetings. Some labs also have meetings attended by individuals working on specific projects or with specific techniques. This is where lab members deal with logistics and technical matters, and they hammer out experiments, trying to get different approaches to work.

Strategy sessions. Should you decide that your research needs to take a new direction, you may want to call an official strategy session. A strategy session helps the group identify the next most important questions and what experiments will answer these questions. Such a meeting also helps the group develop a shared understanding of the lab's direction and clarifies what needs to be done and who is interested in what aspects of the new research area. In addition, these meetings help you determine how potential conflicts and competing interests can be avoided.

> *In my lab, there are five or six breakout groups that meet once a week or two, and that works really well. It gives them a team-building experience.*
>
> —B. Brett Finlay, University of British Columbia

Journal club meetings. These meetings are an integral part of training new scientists and can vary in frequency from weekly to monthly, or as desired. The discussion of a scientific report serves to illustrate how to and how not to construct and test a hypothesis, what constitutes effective analysis, and how to report scientific findings. In addition, a journal club meeting reinforces the idea that reading current papers is essential to keeping up with the field. These meetings also provide an opportunity to communicate your values about science and other people's work.

> *We discuss papers and talk about weaknesses, and it makes it clear that we don't want our papers to have those kinds of weaknesses. I think the scientific rigor issues come up as we go along.*
>
> —Tamara Doering, Washington University School of Medicine

Informal group activities. Organizing social occasions to celebrate a major accomplishment—publication of a paper, a job, a grant—is important for promoting your shared vision of the lab and building morale. In addition, most principal investigators agree that it is important that lab members occasionally socialize in a relaxed, nonwork environment. Such get-togethers can help promote team building and enhance communication among lab members. As you are establishing your lab, you might have to arrange these outings. After a while, they will occur more spontaneously. Don't feel that you always have to participate, and don't feel offended if you are not invited to all after-hours occasions.

Managing Performance

Day-to-day feedback. Give your lab members feedback regularly and immediately. Praise their accomplishments, but also let them know right away when they are not doing what you expect them to do and that there are consequences for this.

> *Although I know it's important, I hate letting people know when their behavior does not meet my expectations. When I first opened the lab, I was more uncomfortable with this than I am now. Basically, I'm quicker to call people on it now. If things are not working and the quality of their work is somehow slipping, or the effort that they are putting in is somewhat slipping, I have an easier time saying, "This isn't right, you have to change it now."*
>
> —Charles Murry, University of Washington School of Medicine

Performance review. Although regular feedback is important, it does not take the place of a formal review. The performance review meeting is an opportunity for you and members of your lab to clarify your expectations, review their recent accomplishments, and set performance goals. It is also a good time to talk about their career goals and how their work in your lab contributes to achieving those goals. Another important purpose of performance evaluations is to give your lab members an opportunity to give you feedback on your leadership style. Work with your institution's human resources department to make sure you conform to your institution's performance management process.

> *The specific goal is that we talk about their career development. I give them a form ahead of time so that they have to think about their major accomplishments, their goals, new directions that interest them, and also about their interactions with me from both sides—how they would like to change what they do, and how they would like to change what I do.*
>
> —Tamara Doering, Washington University School of Medicine

Starting a Research Group in 1978: Are Any of the Lessons Still Relevant?

In his keynote address at the BFW-HHMI Course in Scientific Management, HHMI President and Nobel laureate Thomas R. Cech described his entry into biomedical science in the 1970s.

"In 1978, I moved from MIT, where I had completed a two-year postdoc, to the University of Colorado–Boulder, where I had landed a tenure-track assistant professor position. I was given a former undergraduate teaching lab for my research space, with a formaldehyde-preserved rat still inhabiting one of the drawers, and $20,000 in start-up money to equip it. My teaching assignment was 90 lectures per year, often in courses that I had not taken myself. My new colleagues were pleasant, but they rarely engaged in anything that could be called mentoring. The prevailing attitude was to give new faculty an opportunity to succeed by themselves and come back in seven years to evaluate the results.

"Although clearly many of the pressures and opportunities for new faculty have changed in the past 25 years, many of the challenges I had to meet are the same ones that you are facing now. One of the main challenges concerns the management of people. Over the years, I've had numerous postdoctoral fellows, graduate students, and undergraduates in my laboratory. I've found that it's really important to treat people with respect and to set an example. It's also important to develop a sense of teamwork and identity for your lab. If you get a good environment built up in your lab and you have more people wanting to come into your lab than you have room for—that is a sign of success. So, if I had one piece of advice to give, it's that although you've been hired for your scientific skills and research potential, your eventual success will depend heavily on your ability to guide, lead, and empower others to do their best work."

Excerpts from Dr. Cech's address can be found at *http://www.hhmi.org/labmanagement*.

Appendix 1 shows a sample performance review form courtesy of Dr. Tamara Doering. Dr. Doering sends the form to lab members a few days before the meeting. The form consists of two parts: a self-assessment section that is completed by the lab member before the meeting and a joint feedback section that is completed during the meeting. In addition to a focused discussion of short- and long-term goals, the twice-yearly meeting gives lab members an opportunity to give feedback on Dr. Doering's leadership style. The form offers some suggestions about what to evaluate and how to engage lab members in self-evaluation.

Appendix 2 contains a checklist courtesy of HHMI's human resources department that can help you prepare for a performance feedback session with a lab member.

RESOURCES

Barker, Kathy. *At the Bench: A Laboratory Navigator*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press, 1998.

Barker, Kathy. *At the Helm: A Laboratory Navigator*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press, 2002.

Boss, Jeremy M., and Susan H. Eckert. *Academic Scientists at Work: Navigating the Biomedical Research Career*. New York: Kluwer Academic/Plenum Publishers, 2003.

Committee on Assessing Integrity in Research Environments, Institute of Medicine. *Integrity in Scientific Research: Creating an Environment that Promotes Responsible Conduct*. Washington, DC: National Academies Press, 2002, http://www.nap.edu.

Harmening, Denise M. *Laboratory Management: Principles and Processes*. Upper Saddle River, NJ: Prentice Hall, 2003.

Park, Paula. "Train Your Staff by Talking." *The Scientist* 16(4):47 (February 18, 2002), http://www.the-scientist.com/yr2002/feb/prof2_020218.html.

APPENDIX I

Performance Review Form

Part A. Six-Month Review of Goals

Please complete the first page in advance and bring it to our meeting or e-mail it to me. We will discuss the second page together at our meeting, but you might want to look over the topics.

Name: ____

Date: _____________

I. Accomplishments

II. Goals for the next six months

III. Long-term goals

Performance Review Form (page 2)

Part B. Joint-Feedback Meeting

I. Feedback on mentoring

Frequency of interactions

Quality of interactions

Level of involvement

Positive aspects of interactions

Areas for effort/improvement

II. Comments from mentor

Quality of work
Organization and efficiency
Knowledge base
Communication skills
Working relationships
Leadership/supervisory skills
Areas for effort/improvement

III. Summary of discussion

Strengths/achievements
Areas for effort/improvement
Scientific goals
Long-term plans

Lab Director: ____

Lab Member: ____

Date: ____________

This form is courtesy of Tamara L. Doering, Washington University School of Medicine.

APPENDIX 2

Performance Feedback Checklist for Managers

Opening the performance review discussion

Create a sincere, open, and friendly atmosphere. This includes

- Reviewing the purpose of the discussion.
- Emphasizing that it is a joint discussion for the purpose of problem solving and goal setting.
- Striving to put the employee at ease.

Conducting the performance review discussion

Keep the focus on job performance and related factors. This includes

- Discussing job elements—employee strengths, accomplishments, and improvement needs—and evaluating results of performance against objectives set during previous reviews and discussions.
- Being prepared to cite observations for each point you want to discuss.
- Encouraging the employee to review his or her own performance.
- Using open-ended, reflective, and directive questions to promote thought, understanding, and problem solving.

Encourage the employee to outline his or her personal plans for self-development before suggesting ideas of your own. In the process, you should

- Try to get the employee to set development and improvement targets.
- Strive to reach agreement on appropriate development plans that detail what the employee intends to do, a timetable, and the support you are prepared to give.

Discuss work assignments, projects, and goals for the next performance review period and ask the employee to come prepared with suggestions.

Closing the performance review discussion

Summarize your agreements. In closing, you should

- Summarize what has been discussed.
- Show enthusiasm for plans that have been made.
- Give the employee an opportunity to make additional suggestions.
- End on a positive, friendly, harmonious note.

This form is courtesy of HHMI's Human Resources Department.

Chapter 4

STAFFING YOUR LABORATORY

This chapter is based on information provided by Joan E. Dubinsky, J.D., and Myra L. Jackson, Human Resources Department, Howard Hughes Medical Institute. It also draws from question-and-answer sessions held during the BWF-HHMI Course on Scientific Management and transcripts of interviews with laboratory leaders conducted by Christine Harris, Ed.D., executive coach and management consultant, and Joan C. King, Ph.D., Tufts University School of Medicine, and principal, Beyond Success, to develop their workshop in basic laboratory leadership skills for the course. Additional information was obtained from Ronald B. Corley, Ph.D., Boston University School of Medicine; Tom Misteli, Ph.D., National Cancer Institute, National Institutes of Health; Klaus R. L. Nüsslein, Ph.D., University of Massachusetts–Amherst; and some of the resources noted in this chapter.

Staffing your lab with the right people is one of the most important things you can do to ensure the success of your research. This chapter focuses on four laboratory positions—technician, postdoc, graduate student, and undergraduate—although much of the material would be relevant for anyone you bring on board. The chapter reviews issues to consider when determining your staffing needs and suggests strategies to help you manage the process for recruiting, interviewing, and evaluating applicants. The chapter also offers guidance on what to do if you have to ask someone to leave your lab. (For a discussion of skills needed to manage the people in your lab and motivate them to work productively, see chapter 3, "Defining and Implementing Your Mission.")

GETTING STARTED

The process for staffing your lab will vary depending on the position you are trying to fill and the extent to which your institution's human resources (HR) department is involved. Because the hiring process in an academic setting can be protracted and time-consuming, you should involve your department's administrative staff or your institution's HR department from the beginning.

Know the Difference Between Employees and Students

It is important to distinguish between employees and students. Generally, technicians and postdocs are considered to be employees of your university or research institution. They receive regular wages and have taxes withheld, and federal and state laws and your institution's personnel policies apply to their employment. On the other hand, undergraduate and graduate students are just that—students. Although they may receive a stipend for work in your laboratory, their relationship to you in almost all cases is that of learner to teacher, not employee to employer. For the most part, students work in your lab to gain experience and to learn how to do science, not because they receive monetary compensation.

In addition, employees are "hired" and "fired," and students are "assigned" to a lab and "released" from it. Although this may seem like mere wordplay, the nuances of these relationships are important because of the legal implications.

Avoid Discrimination

In the United States, many laws—at the federal, state, and local levels—guide and control how you as the employer's representative work with other employees, particularly those you supervise. These laws determine many aspects of the employer/employee relationship. One very important principle to follow is to avoid discrimination on the basis of an individual's membership in a protected group or an individual's protected characteristic. Generally, this means that you cannot discriminate in an employment-related decision (such as interviewing, recruiting, selecting, hiring, training, evaluating, promoting, disciplining, or terminating) on the basis of someone's race, color, religion, age, sex, national origin, sexual orientation, marital status, mental or physical disability, or other protected status. Work with HR and with knowledgeable people in your department to ensure that you follow the law and your institution's policies and procedures.

Determine Your Staffing Needs

Your decision to take on staff will depend on several factors, such as the provisions of your start-up package, the stability of your external funding sources, the progress of your research, and even your personal preferences about performing various laboratory tasks. Established scientists caution new principal investigators against rushing out and hiring people just to fill an empty lab. Before you bring on staff, think carefully about the consequences. Will you be able to recruit the caliber of people you need? Can you make the time to train and mentor others? Remember, you need to preserve sufficient time and space for your own work at the bench.

Often, the first person a new investigator hires is a lab technician. This versatile lab member can help you with time-consuming initial tasks, such as logging in and setting up equipment and handling routine tasks that keep your laboratory working. Although your budget may more easily accommodate a junior technician, you might benefit more by hiring an experienced technician who can help train other staff as they come on board. Some experienced technicians can also contribute in substantive ways to your research project. A technician who is familiar with the administrative processes of your institution can also be extremely valuable.

> *Early in my career, when I couldn't attract top postdocs, I put my energy into graduate students and technicians. The graduate students are like raw lumps of clay that have the opportunity to mold themselves into something really great.*
>
> —Thomas Cech, HHMI

Consider bringing a graduate student on board once your lab is running and you have the time to invest in training. Working with your technician and graduate student can provide you with additional intellectual stimulation, and when each is able to work independently, you should have more time for grant writing and doing experiments. Hire a postdoc when your main project is well under way and you have enough other projects, so that you can turn one of them over to the postdoc and allow him or her to have a great deal of responsibility.

You may want to be cautious about taking on undergraduates because of the large time investment needed to make them fully a part of the lab. If you decide to take on an undergraduate, consider limiting the initial assignment to one semester. At the end of that time, determine whether the student should continue for a second semester. (Additional considerations for working with undergraduates and other lab members can be found in chapter 5, "Mentoring and Being Mentored.")

Resource: Job Descriptions

The University of Michigan offers helpful information about preparing job descriptions (University of Michigan Employment and Executive Services, "Conducting a Successful Employee Selection Process," http://www.umich.edu/~hraa/empserv/deptinfo/empsel.htm).

Write the Job Description

The next step is developing a job description for the open position. First, identify and prioritize the initial and ongoing lab tasks for which you need support. Then determine the qualifications needed to best complete these tasks and develop a general plan for allocating the person's time. Most HR departments have job descriptions that you can use as models. Bear in mind that the position will have to fit within your institution's established compensation and classification system. The process may be more complicated if unions represent identified groups of employees at your institution.

RECRUITING APPLICANTS

Get the Word Out

Informal methods. Try to recruit by word of mouth. Ideally, you want people to seek you out. Meetings and seminars where you present your work are good venues to reach graduate students and postdocs, as well as lab technicians who are not employed by your institution. Another strategy is to include a statement on your Web site inviting people to contact you if they are interested in working with you. As you get to know students in your classes, you may find some who are interested in learning more about your work and carrying out a research project in your laboratory. In addition, you may be able to recruit graduate students from those who rotate through your lab as part of the curriculum.

Formal advertisements. To recruit postdocs, you may decide to place advertisements in journals such as *Science* (http://recruit.sciencemag.org), *Cell* (http://www.cell.com), and *Nature* (http://www.nature.com), both in hard copy and on the Web. Other resources for advertising are the Federation of American Societies for Experimental Biology's Career Resources Web site (http://career.faseb.org/careerweb/), *Science*'s Next Wave (http://nextwave.sciencemag.org/jobsnet.dtl), and the listserves maintained by professional associations such as the Association for Women in Science For any advertisements you place, make sure you follow your institution's policies.

What Do You Have to Offer?

As a beginning investigator, you may find it a challenge to recruit the people you want, especially postdocs and experienced lab technicians. Here are some things you can do to increase your chances:

- Promote your vision. When you talk to the applicant, take time to identify your vision for your lab. Your excitement about your work and your lab will excite and interest potential staff.
- Communicate your lab culture. Think about how to create a lab environment that allows you and your staff to work efficiently and harmoniously. If good communication, collaboration, and cooperation are valued concepts in your lab, they can be selling points in recruitment.
- Convey your commitment to mentoring. Let potential staff know that they will be working directly with you and that you have an interest in helping them in their careers.
- Offer flexibility where you can. Flexibility, especially about assignments or research avenues, is attractive to most job applicants.
- Provide a realistic level of reassurance regarding the stability of your funding. Potential staff are likely to be aware that the money to pay their salaries may be coming from your research grants.

What *They* Are Looking For

Lab technicians. Technicians may be attracted to a beginning laboratory because they are eager for the opportunity to work closely with the principal investigator and are interested in learning new techniques and being included on papers. Good salaries and status (related to publishing papers) may be of prime importance to career lab techs, whereas experience, especially experience that will help them decide whether to go to graduate school or medical school, may be more important to short-term lab technicians.

Graduate students. Graduate students are often attracted to new labs because, like lab technicians, they are eager for the opportunity to work directly with principal investigators. Mentoring graduate students can be time-consuming, especially for the first few months. Therefore, you may want to sign up your first graduate student

> *When I talk to students about what kind of a lab they should join, I always tell them that it's a very special experience to go into the laboratory of someone who is just beginning an independent research career, because the principal investigator is in the lab all the time working shoulder to shoulder with them. There is a lot of excitement and anticipation about exactly which direction the laboratory will go.*
>
> —Thomas Cech, HHMI

when your lab is running well and you have time to work with each student properly. Thoughtful mentoring of graduate students early in your career will help you develop a positive reputation and will increase your ability to attract other graduate students. On the other hand, if your first graduate students have negative experiences in your lab, they will quickly share this with their peers, and your ability to recruit students will suffer greatly.

Undergraduate students. Undergraduate students may want to work in your lab because they are curious about research, perhaps because they have talked with their peers who are having a good experience in a lab and want to find out whether they should consider graduate study. Or they may be looking for academic credit, funding, or recommendations for graduate or medical school. Try to select undergraduates who are motivated to contribute to the productivity of your lab.

Postdocs. It may take two to three years for you to recruit a postdoc with the desired qualifications. Most postdocs are attracted to more established labs because these usually are better launching pads for their careers. Nevertheless, some postdocs might be attracted by your research area, your concern for furthering their careers, or your institution's reputation and geographical location. If you have a good reputation from your own postdoctoral work, you may be able to recruit highly qualified postdocs right away. Having a policy that allows postdocs to take their projects, or some aspect of their projects, when they leave your lab is also a potent recruitment tool.

SCREENING APPLICANTS

Many principal investigators do all the screening for jobs for which scientific qualifications are important but may rely on HR to do the initial screening for administrative positions. However, as a beginning investigator, you probably will not be swamped with applicants, so you may want to screen all the applicants yourself.

When you review résumés, check skills against qualifications and look for transferable skills. Always review résumés carefully—some applicants may inflate their experience. Gaps in employment and job-hopping may be signs of problems.

Tips for Specific Positions

For an applicant to a postdoc position, consider publication *quality*—not just quantity—and the applicant's contribution. A first-author citation indicates that the applicant probably spearheaded the project. A middle-author citation indicates that the applicant contributed experimental expertise but may have had less to do with the project's intellectual construct. Although it may not be realistic for a beginning investigator, try to find a postdoc with a record of accomplishment—usually two first-author papers—that indicates he or she will be able to obtain independent funding.

If a technician has contributed to publications, you should evaluate them to determine whether the technician has the ability to contribute intellectually as well as technically to the lab. The résumés of less-experienced lab technicians may not show a record of contributions to published papers or other indicators of productivity. Carefully check references to find out about their capabilities.

For a graduate student, speak informally with other people who have worked with the student, including teaching assistants who may know how the student has performed in a laboratory course. Take the student to lunch and see how articulate, bright, and energized he or she is. When selecting graduate students and undergraduates, remember that a high grade-point average is no guarantee of success in your lab.

Check References Directly

For a variety of reasons, including fear of a lawsuit or hurt feelings and concerns about confidentiality, people rarely write negative letters of recommendation. Therefore, you need to contact applicants' references by telephone. You may want to talk with HR in advance about your institution's policies on conducting reference checks.

What to ask a reference. When discussing an applicant with someone who has provided a reference for him or her:

- Describe the job and the work atmosphere you want to create.
- Ask short, open-ended questions, and avoid asking questions to which the desired response is obvious.
- You might want to ask, Why is this person leaving? Is he or she reliable? Would you rehire this person? What are this person's strengths and weaknesses? What are you most disappointed in with respect to this person?
- Probe for further information, and ask for examples. Do not settle for yes or no answers.
- Try to determine whether your lab values are similar to those of the reference, perhaps by asking about the reference's lab and philosophy. This information should help you decide how much weight to give to the reference.

Contact all references. You are trying to make a decision about someone with whom you will be spending many of your waking hours—make sure you get the information you need. To correct for bias in the responses of any one reference, make sure you call all of an applicant's references, even those overseas. Don't rely on e-mail to make the reference check—you're unlikely to get the kind of information you're looking for.

Sometimes, applicants won't give the name of a current supervisor as a reference. If that is the case, you must respect their request for confidentiality. However, you should probably ask why the applicant doesn't want you to call. You can also ask for additional references who can provide you with information about this person's work habits, accomplishments, and history.

Common Types of Interview Questions

Open-ended questions cannot be answered yes or no; for example, Tell me about yourself. The applicant determines the direction of the answer.

Directive questions solicit information about a specific point; for example, What skills do you have for this position? The interviewer determines the focus of the answer.

Reflective questions solicit information about a past experience that might serve to predict the applicant's future performance; for example, Describe a time when you demonstrated initiative.

Further Screen Applicants by Telephone

You may want to screen promising applicants by telephone before inviting any of them for a formal interview. As with interviewing references, focus on asking open-ended questions. For foreign applicants, open-ended questions are particularly helpful in determining the person's ability to communicate effectively in English. The appendix (page 79) shows a sample outline that can help you in your phone interviews with applicants. (Consider developing a similar form for talking to applicants' references.)

INTERVIEWING APPLICANTS

Invite Applicants to Visit Your Lab

After you have completed the initial screening, narrow your list of potential applicants to a reasonable number of good prospects. Then, invite each person to visit your lab for a formal interview. Remember, the initial telephone screening interview is no substitute for this in-person interview. (Your institution may be willing to pay the travel costs of applicants for a postdoc position.) In addition to the interview with you, the applicant should meet informally with other members of your lab or, if this is your first hire, meet with your colleagues, perhaps over lunch or dinner. Also arrange for the applicant to spend some time with other lab members and colleagues without you. For a postdoc position, require that each applicant deliver a seminar to members of your lab or department, and then get their feedback.

Share your requirements and expectations for the successful applicant with the other people you have asked to help conduct interviews. This way everyone will be looking for the same attributes and skills.

> *The presentation [postdoc candidates] give to the lab is key. You can check out their ability in public speaking, which is important because in science a lot of times you are a salesperson. I usually try to ask them some decently tough questions—not to try to stump them, but just to make sure that they can think on their feet, because you have to do that a lot as a scientist.*
>
> —B. Brett Finlay, University of British Columbia

Conduct a Structured Interview

The goal of the structured interview is to use a standardized set of predetermined questions to gather key information in an efficient, equitable, and nondiscriminatory manner from all qualified applicants. You want to give each applicant a fair opportunity to compete for the position. Your questions should be

- Outlined ahead of time so that you ask basically the same questions of each applicant
- Job related and legal (avoid asking personal questions)

- Short and open ended, like those used when checking references
- Focused and designed to elicit information (avoid asking philosophical questions)

Tailor your follow-up questions to reflect each applicant's responses and to encourage each applicant to provide examples from his or her own experiences.

Topics to Avoid

Most illegal or ill-conceived questions deal with race, color, national origin, sex, religion, disability, or age. You should not ask about sexual orientation, marital status, marriage plans, pregnancy or plans for having children, the number and ages of dependent children, child-care arrangements, or other non-work-related matters. Remember that job-related questions are the only appropriate means by which to determine skills and qualifications. Your HR department can provide more guidance on topics to avoid during interviews.

Develop the Interview Questions

As you develop your questions, think about how to determine whether the applicant has the knowledge, technical skills, and personal qualities that you need. Review the job description you created earlier, the applicant's résumé, and your notes from your conversations with the references to identify any items or information gaps that need clarification in the interview.

> *I ask them, Why do you want to come to this lab? What interests you? What areas do you want to work in? I'm looking for people who say they want to broaden their horizons, not those who want to continue doing the same thing.*
>
> —B. Brett Finlay, University of British Columbia

Sample interview questions. *At the Helm: A Laboratory Navigator* by Kathy Barker (see "Resources," page 78) contains a list of general questions as well as those geared for specific laboratory positions and for determining specific personal characteristics. In addition, you may want to tailor the following questions to the position for which you are interviewing.

Experience and Skills

- Tell me about your most significant accomplishments.
- Tell me the part you played in conducting a specific project or implementing a new approach or technology in your lab.
- I see you have worked with [insert specific technology or technique]. Tell me about its features and benefits.

Commitment and Initiative

- Why do you want to work in my lab?
- Where do you see yourself in five years?
- What kinds of projects do you want to do? Why?
- Tell me how you stay current in your field.
- Describe a time when you were in charge of a project and what you feel you accomplished.
- Tell me about a project or situation that required you to take initiative.

Working and Learning Styles

- What motivates you at work?
- Would you rather work on several projects at a time or on one project?
- Do you learn better from books, hands-on experience, or other people?
- Tell me about a project that required you to work as part of a team. What was the outcome of the team's efforts?
- How would you feel about leaving a project for a few hours to help someone else?
- If you encountered a problem in the lab, would you ask someone for help or would you try to deal with it yourself?
- You may be asked to work after hours or on a weekend. Would this be a problem?

Time Management

- How do you prioritize your work?
- What happens when you have two priorities competing for your time?

Decision Making and Problem Solving

- What is your biggest challenge in your current job? How are you dealing with it?
- Tell me about a time when you made a decision that resulted in unintended (or unexpected) consequences (either good or bad).
- Give me an example of a situation where you found it necessary to gather other opinions before you made a decision.

Interpersonal Skills

- How important is it to you to be liked by your colleagues and why?
- If you heard through the grapevine that someone didn't care for you, what would you do, if anything?
- Tell me about a situation in which your work was criticized. How did you rectify the situation?
- Describe a scientist whom you like and respect. What do you like about this person?

Cultural differences. You may find yourself considering applicants from different cultures whose beliefs, such as those about self-promotion, collaboration, and deference, may differ from the beliefs commonly held in the United States. To learn more about cultural factors and to ensure you are considering all candidates fairly, refer to Kathy Barker's *At the Helm: A Laboratory Navigator.* The author also provides a list of useful questions you might ask a candidate, including the following:

- How do you feel about getting in front of a group and describing your personal accomplishments?
- How would you respond if a more senior lab colleague took credit for your project?
- If you did not understand something, would you persist in asking for help even if the principal investigator got annoyed?

> *My favorite questions are, What do you want to be doing five years from now? Ten years from now? What area do you want to be working in? These give me an idea of just how mature [applicants] are in terms of how much they have thought about what they want to do and how committed they are.*
>
> —Gail Cassell, Eli Lilly and Company

Tips for Conducting an Interview

- Before you begin, try to make the applicant feel comfortable. Make appropriate small talk, offer a beverage, and compliment the applicant on making it thus far in the selection process. Remember that the applicant is also deciding whether he or she wants to work for you.
- Develop professional rapport, but avoid a social atmosphere:

  Explain how the interview will be structured.

  Briefly describe the selection process.

  Outline the responsibilities for the open position.

  Convey your expectations about the job. Include values that may seem obvious to you, such as your commitment to lab safety and scientific rigor.

  Keep in mind the topics to avoid.

- Take brief notes. Record actual answers to questions, not evaluative or conclusive comments.
- Listen carefully. Let the applicant do most of the talking.
- Develop a high tolerance for silence. Give the applicant a chance to think and develop thoughtful answers to your questions.

- Give the applicant many chances to ask questions. This will give you some insight into what is important to him or her.
- Never make promises or give commitments, even those that seem innocent to you.
- Ask the applicant about his or her timetable for leaving the current job, even if you asked it during the telephone interview.
- Before ending the interview, do the following:

  Give the applicant a chance to add anything else he or she thinks may be important for you to know in making your decision.

  Make the applicant aware of the next steps, such as additional interviews and the time frame for hiring.

  Thank the applicant for his or her time.

Special Considerations

This section is especially relevant for interviewing technicians, postdocs, and other professional laboratory staff.

Pregnancy. If, during the interview, a well-qualified applicant tells you she is pregnant, remember it is illegal to discriminate against someone because she is pregnant. Familiarize yourself with your institution's policies on maternity leave before making any statements to the applicant about what length of maternity leave would be permitted and whether the leave would be paid or unpaid. Similarly, your institution may have a policy on paternity leave that may apply to an applicant.

Visas. If you are filling a postdoc position and are dealing with foreign applicants, remember that visa rules and requirements are complex and change frequently. Some visa types are more desirable from the perspective of the applicant (e.g., because they allow for concurrent application for permanent residence in the United States). Other visa types are more desirable from the perspective of the employer (e.g., because they are easier to administer). Special concerns for any type of visa may include visa arrangements for a spouse and other family members, requirements to return to the home country, and employment implications. Keep in mind that obtaining a visa can be a very slow and lengthy process. (Obtaining visas to travel to the United States has become even more time-consuming given increased U.S. security concerns and clearance.)

Consult HR, your institution's international office, and your department's administrative staff about visa rules and requirements. They can also help you determine which visa is most appropriate for a given applicant. You can also check the latest information from the State Department (http://www.travel.state.gov/visa_services.html) and the Bureau of Citizenship and Immigration Services (formerly the Immigration and Naturalization Service, http://www.immigration.gov/graphics). The site http://www.visalaw.com may be helpful. A brief visa primer also is available in *At the Helm: A Laboratory Navigator* by Kathy Barker.

In addition, try to determine the consequences (for you as well as the applicant) if poor performance forces you to ask the postdoc to leave your laboratory. Because this is an extremely complex area of immigration law, it is important that you consult your institution's HR or legal department and follow their advice.

EVALUATING APPLICANTS

Before you begin evaluating an applicant, make sure that you have all the necessary information. Conduct any reference interviews that you were unable to complete before the interview. Gather opinions from others who have met with the applicant. As needed, seek guidance from your department and HR.

Maintaining Objectivity

As in any situation that involves interpreting interpersonal behavior, objectivity in evaluation may be difficult. Nevertheless, try to avoid the following:

- Relying too heavily on first impressions
- Making a decision too early in the interview, before asking all questions
- Downgrading an applicant because of a negative characteristic that is not relevant to the job itself
- Allowing a positive characteristic to overshadow your perception of all other traits, sometimes called the "halo effect"
- Judging the applicant in comparison with yourself
- Comparing applicants with one another rather than with the selection criteria (e.g., if you have been interviewing poorly qualified applicants, you may rate average applicants highly)
- Allowing factors not directly related to the interview to influence your estimation of the applicant (e.g., interviewing during times of the day when you may be tired)

What to Look For

In addition to determining whether the applicant has the qualifications required to perform well in your lab, you should also keep the following points in mind:

- Consider the "chemistry." First and foremost, pay attention to your intuitive reaction to the person. Look for a person who is interested in, and able to get along with, others.
- Ascertain whether the applicant is a good fit. Keep in mind that you are building your team and need people with the skills and personalities to get things done. Look for people who have a track record of productivity and have demonstrated an ability to learn new skills.
- Seek someone who has a passion for science and a strong work ethic. Enthusiasm, a can-do attitude, and the willingness to go the extra mile are critical attributes.
- Check the applicant's career plans. Knowing what the applicant wants to be doing in 5 or 10 years can give you insight into his or her scientific maturity and creativity, as well as his or her commitment to a specific research area.

- Be certain the applicant is committed to good research practices. Record keeping and reporting results are even more important now than in the past because of patent and other legal issues. Insist on the highest level of scientific integrity from anyone you are considering.

> *If people in the lab had reservations about whether they would get along with someone, I probably wouldn't bring that person in.*
>
> —Tamara Doering, Washington University School of Medicine
>
> *There is enough competition in the field already, and you don't need it in the lab.*
>
> —B. Brett Finlay, University of British Columbia
>
> *If people don't seem like they would be fun to work with, I would use that as a reason to turn them down. Even if they have a lot of papers and seem to be very smart, I think you might want to think twice about hiring them.*
>
> —Thomas Cech, HHMI

Red Flags

Warning signs during an interview that should alert you to potential problems include:

- Unwillingness to take responsibility for something that has gone wrong.
- Complaining about an adviser and coworkers.
- Demanding privileges not given to others.
- Delaying answering questions, challenging your questions, or avoiding answering them all together. (Humor and sarcasm can be tools to avoid answering questions.)
- Unless you have been rude, responding to an interview question with anger is never appropriate.
- Incongruence between what you hear and what you see (e.g., downcast eyes and slouching are not signs of an eager, assertive candidate).
- Trying to control the interview and otherwise behaving inappropriately.

MAKING THE OFFER

This section is especially relevant for hiring technicians, postdocs, and other professional laboratory staff.

Before you make an offer, check with your department to learn which items of the job are negotiable and whether you are responsible for negotiating them. HR or your department should provide you with institutional salary ranges for the position. In some institutions, HR will determine the initial salary that you can offer. In other institutions, you may be given some leeway within a predetermined range that is appropriate for the job description.

Once you have identified the person you wish to hire, contact him or her by telephone to extend the offer and to discuss start date, salary, and other conditions of employment. (Be sure to check with HR first to determine whether you or they will make this contact and cover these issues.)

Inform All the Applicants

First, inform the person you have selected. If he or she turns down the offer, you can move to your second choice.

Once you have filled the position, let the other applicants know. You do not need to give a specific reason for your decision not to hire an applicant. However, you may state that the selected candidate had better qualifications or more relevant experience or that it is your policy not to disclose this information. Check with HR and your department's administrative staff about policy in this area.

The Offer Letter

After you and the selected candidate have confirmed the job details via telephone, your institution will send the formal offer letter. Usually, it confirms the offer terms, including start date and salary. Coordinate with HR and your department's administrative staff to determine what information to include.

An offer letter to a foreign national may need to include more information. For example, it may need to spell out that employment is contingent on the ability to obtain authorization for the individual to work in the United States and to keep the work authorization in effect. HR or your department's administrative staff will help you follow policies correctly in this type of situation.

MANAGING YOUR LABORATORY STAFF

For a discussion of the skills needed to manage the people in your lab day to day and get them to work productively, see chapter 3, "Defining and Implementing Your Mission." Also consult your institution's HR staff—they have expertise and resources to help you set performance expectations, maintain performance records, motivate staff and evaluate their performance, deal with behavior or performance problems, and manage issues related to staff promotion and job growth.

ASKING STAFF TO LEAVE

Despite all your best efforts, you may need to ask someone to leave your lab. Before considering dismissal, be sure that you have tried various avenues to help this person be successful in your lab. This may include assistance with scientific techniques and counseling for behavioral issues. Also, be certain that your dissatisfaction is based on objective observations, not your personal biases.

Try to determine whether you think the person would be better off in another lab or should consider another career. For students and postdocs, this usually means talking with that person and his or her faculty adviser or the graduate student committee. It may be best to suggest to someone that research is not for them if you truly believe the profession is not suited to his or her talents or personality. You can provide that person with encouragement and options. For example, *Science*'s Next Wave Web site provides a range of career options for people with bioscience backgrounds (*http://nextwave.sciencemag.org/trn.dtl*).

There are no hard and fast rules about how a manager should address performance or behavior problems in the lab. However, keep in mind the following, especially if you're thinking about letting someone go:

- Be fair.
- No surprises.

Fairness dictates that lab members receive some type of notice about unsatisfactory performance. Make sure the person knows your concerns and is given a reasonable opportunity to respond and turn things around.

Keep a Record

You should outline and set expectations for the performance and conduct of everyone in your lab. The process is more formal for employees than it is for students.

For technicians, postdocs, and other professionals, job expectations should be made clear. Don't expect your employees to read your mind about what you want them to accomplish and how you want to accomplish it. Keep good records of your conversations with everyone so that you can track your own efforts and determine whether your staff has met expectations. If a lab member is not meeting expectations, make

> *When postdocs don't fit in, I try to help them find other positions. Sometimes they realize that this isn't where they belong and they do it themselves. I say, What do you want to work on? Let's see what we can do. People are different, sometimes things don't work out, and this is not a reason to be defensive. The focus is to help people do what they value.*
>
> —Suzanne Pfeffer, Stanford University School of Medicine

sure you document your attempts to help the person improve his or her performance or prepare for a new career. Should you ultimately have to terminate this person, these records can help avert external challenges to your decision.

Deliver a Warning

Warnings should be delivered by you, calmly and in private. Listen to the employee's point of view and explanation. Develop a plan for addressing the problem with benchmarks and timelines. You may want to commit your action plan to writing. If you provide advance notice, employees will not be surprised when you take forceful action concerning unsatisfactory performance or behavior.

If You Decide to Terminate

An employee with serious work-related problems is a disruptive force and, especially in a small lab, can significantly retard research progress. Although it is not easy to decide to terminate someone, those investigators who have had to release staff say that in retrospect their biggest mistake was not doing it sooner.

To be fair to yourself and your staff and to avoid lawsuits, an involuntary termination should never happen out of the blue unless it is the result of substantial misconduct, such as clear fraud or violence in the workplace. Always avoid firing on the spot. You should find a way to calm the situation so that you don't take precipitous action. A suspension with or without pay may be a good option for the short term while you consider the situation. If you have decided that termination is your only solution, consult with HR as soon as possible to ensure that you are complying with institutional and legal requirements relating to termination and correctly documenting your actions.

Questions to ask yourself before letting someone go. HR professionals recommend that, if circumstances permit, you ask yourself the following questions and document each of the actions before proceeding:

- Have you given the person at least some type of notice or warning?
- Have you made it clear to the person what he or she is doing wrong?
- Has the person received counseling or assistance in learning new or difficult tasks? If so, how much?
- Are you treating (or have you treated) the person differently from other staff in your lab?
- Are you following written procedures and institutional policies?
- Does the documentation in the personnel file support the reason for discharge?

Ideally, you have conducted regular and candid performance reviews with all your laboratory staff and now can use this documentation to help support your decision. (For a discussion of conducting performance reviews, see chapter 3, "Defining and Implementing Your Mission.")

How to terminate. Terminating anyone from your lab is a confidential matter and should not be discussed, before or after the fact, with others in the lab. A termination meeting should be conducted by you, the investigator, in your office, in a way that is private and respectful. (You can always ask HR for assistance if you are unsure how to proceed or if you suspect that your employee may act inappropriately.)

Prepare for the meeting. Develop a script and practice it until you can convey the information confidently. Keep in mind that what is said during the termination meeting can become part of the basis for a subsequent challenge. Remember to

- Be polite.
- Stay focused on the issue at hand. Get to the point quickly. Explain the decision briefly and clearly. Don't apologize or argue with the employee in an effort to justify your decision.
- Avoid laying blame.
- Arrange to have scientific materials and equipment and supplies returned to you, including lab notebooks; protocol books (unless it is a personal copy); lists of clones, cells, and experiments in progress; and keys.
- Let the employee have an opportunity to have his or her say, and pay close attention to what is being said.
- Refer the employee to HR or to the office responsible for discussing benefit eligibility.
- Take notes that document this meeting and convert them into an informal or formal memo to file.
- Try to part on cordial terms. Science is a small community, and your paths may cross again.

Termination letters and references. As part of final documentation, a termination letter may be required by your institution or by state law. In addition, you may be asked for, or may wish to offer, a reference. Check with HR about proper procedures.

Visa considerations. Consult with HR or your department's administrative staff about visa issues before terminating a foreign national employee. Be certain that you are not legally responsible for continuing to pay the salary of someone no longer working in your lab. Again, it's better to understand these requirements *before* you hire someone with a visa.

RESOURCES

Austin, Robert D. "Managing Knowledge Workers: Evolving Practices and Trends." *Science*'s Next Wave (April 26, 2002), http://nextwave.sciencemag.org/cgi/content/full/2002/04/25/5.

Barker, Kathy. *At the Helm: A Laboratory Navigator*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press, 2002.

Brickley, Peg. "Protecting Prized Personnel from Predators." *The Scientist* 15(17):26 (September 3, 2001), http://www.the-scientist.com/yr2001/sep/prof1_010903.html.

Brickley, Peg. "Transforming Scientists into Managers." *The Scientist* 15(23):33 (November 26, 2001), http://www.the-scientist.com/yr2001/nov/prof_011126.html.

Devine, Kate. "Scientist Reader Survey: The Postdoc Experience." *The Scientist* 15(2):29 (January 22, 2001), http://www.the-scientist.com/yr2001/jan/prof2_010122.html.

Federation of American Societies for Experimental Biology. Career pages, http://career.faseb.org./careerweb/.

Harmening, Denise M. *Laboratory Management: Principles and Processes*. Upper Saddle River, NJ: Prentice Hall, 2003.

HRhero. "The Art of Firing," parts 1, 2, and 3, http://www.hrhero.com/topics/fire/fire-art1.shtml.

Rehrig, Norita H. *Six Steps to Successful Interviewing: How to Build Your Reputation by Picking the Winners*. Bethlehem, PA: College Placement Council, 1990.

Science's Next Wave. Career Transitions. Articles on science careers, http://nextwave.sciencemag.org/trn.dtl.

Science's Next Wave. JobsNet. Links to job listings, http://nextwave.sciencemag.org/jobsnet.dtl.

Siering, Marlene. "Hire the Best." *Denver Business Journal* (November 17, 1997), http://www.bizjournals.com/denver/stories/1997/11/17/smallb2.html.

University of Michigan Employment and Executive Services. "Conducting a Successful Employee Selection Process," http://www.umich.edu/~hraa/empserv/deptinfo/empsel.htm.

University of Michigan Employment and Executive Services. "Electronic Recruitment Resources," http://www.umich.edu/~hraa/empserv/deptinfo/electronic.htm.

Varnadoe, Lionel A. *Medical Laboratory Management and Supervision: Operations, Review, and Study Guide.* Philadelphia: F. A. Davis Company, 1996.

APPENDIX

Telephone Interview Outline

Date: ____

Candidate: ____________________________________

Investigator's Questions (Use open-ended questions, and ask for examples.)

To see if we might fit, give me an idea of what you are looking for.

What are your goals for this position? (short-term expectations, long-term plans)

Tell me about yourself as a scientist:

- What are your strengths?
- What are your weaknesses?
- What do you want to learn?
- What are you looking for in a supervisor?

What is your preferred interaction style? (with me, with others, on joint projects)

Timing, current job

Visa status

Investigator's Comments

Background, interests, goals

The projects we are working on

What I am looking for

What I expect (enthusiastic, interested, communicative, a hard worker, responsible)

What I will offer (be there, help, communicate, support career with communication about goals, funding for [e.g., length of time])

The university, department, town

Timing, constraints

This interview form is adapted from one developed by Tamara L. Doering, Washington University School of Medicine.

budget
publications

Chapter 5

MENTORING AND BEING MENTORED

This chapter is based on a pair of sessions held at the BWF-HHMI Course in Scientific Management. The sessions were organized by Victoria McGovern, Ph.D., Burroughs Wellcome Fund. The panelists for the first session were Stephen L. Hajduk, Ph.D., University of Alabama–Birmingham (now at the Marine Biological Laboratory); David S. Roos, Ph.D., University of Pennsylvania; and Dorothy E. Shippen, Ph.D., Texas A&M University. Panelists for the second session were Elizabeth Keath, Ph.D., Saint Louis University, and E. Lynn Zechiedrich, Ph.D., Baylor College of Medicine. The chapter also draws from transcripts of interviews with laboratory leaders conducted by Christine Harris, Ed.D., executive coach and management consultant, and Joan C. King, Ph.D., Tufts University School of Medicine, and principal, Beyond Success, to develop their workshop in basic laboratory leadership skills for the course. Additional information was obtained from Gina Turrigiano, Ph.D., Brandeis University, and some of the resources noted in this chapter.

As a principal investigator, you probably will hire one or more technicians, assume responsibility for the direction of graduate students, and take on several postdocs. In addition, several of your undergraduate students may be thinking about careers in science. Each of these individuals will look to you as a mentor. If your reputation as a good mentor gets around, young scientists outside your lab may also begin knocking on your door. At the same time, you will continue to be in need of guidance for your own continuing professional development. This chapter describes the process of mentoring, with the focus on mentoring the people working in your lab. The chapter also suggests desirable personal qualities and plans of action for both mentors and trainees.[1]

WHAT IS MENTORING AND WHY IS IT IMPORTANT?

Scientific mentoring is a *personal*, one-on-one relationship between a more experienced scientist and a junior scientist or a scientist-in-the-making. The mentor is exposed to the trainee's energy and ideas, and the trainee receives the guidance and encouragement necessary for professional development.

Mentors usually include those who are officially responsible for the work of junior scientists or students, such as the principal investigator or a formal adviser. However, it's also important to have mentors who are outside the direct line of authority. These mentors can be especially helpful in providing guidance when formal advising relationships become strained or when the personal or professional interests of the trainee differ from those of the formal mentor.

1. In this chapter, the people you mentor are referred to as "trainees," although not everyone you mentor may be receiving training in your lab.

Not only does mentoring benefit the trainee, it also benefits the mentor. As a mentor, you derive personal satisfaction in helping nurture the next generation of scientists. Your scientific achievements are carried forward by those you have mentored. As your trainees embark on new projects, you are naturally kept abreast of the latest scientific developments. In addition, your professional network expands as your trainees expand their professional horizons.

Traits of a Good Mentor

Good mentors often share some of the following personal qualities:

- *Accessibility:* An open door and an approachable attitude.
- *Empathy:* Insight into what the trainee is experiencing.
- *Open-mindedness:* Respect for each trainee's individuality and for working styles and career goals different from your own.
- *Consistency:* The habit of acting on your principles and being reliable.
- *Patience:* Awareness that people make mistakes and that each person matures at his or her own rate.
- *Honesty:* Ability to communicate the hard truths about the world "out there" and about the trainee's chances.
- *Savvy:* Attention to the pragmatic aspects of career development.

Confidentiality in Mentoring

As a mentor, you may be privy to a lot of information about your trainees, from their past professional accomplishments and failures to their personal relationships and financial situation. You should treat all information as confidential. Your trainees should feel that they can trust you with whatever problems they share with you.

A MENTOR'S RESPONSIBILITIES

Mentoring entails substantial commitments of time, energy, and good will. A significant portion of your time must be allocated to each trainee, and you must be prepared to obtain the resources the trainee needs. In addition, you should use your experience and contacts to help the trainee establish a professional network.

Question: How do I say no to being someone's mentor?

Answer: Be kind: Imagine yourself in your requestor's shoes. Give reasons related to your own limitations. However, be clear and firm. Do not invite misunderstanding. Suggest alternative sources of help, but check first with the potential mentor.

Choosing Whom to Mentor

You will have to make case-by-case judgments about which mentoring relationships you can afford to enter into and how intensive each one should be. There are some people for whom you are clearly responsible, such as the people working in your lab. The students in your courses also have legitimate expectations of you. Others, outside your lab or courses, may come to you for advice. Some people are more promising than others, and you want to nurture their talent. Others have interests closely related to yours, and it is natural for you to want to work closely with them. Still others show promise but are needy in some respect; for example, their skills are not fully developed or they need help focusing their efforts. With the people in your lab, the important thing is to be fair and avoid favoritism. With the people outside your lab, you need to avoid overextending yourself or setting up expectations you can't fulfill.

Defining Your Role as a Mentor

Generally speaking, a mentor provides whatever is needed to further a trainee's professional development but is not necessarily a friend. You should offer to teach technical skills, give advice about the political aspects of science, and suggest networking opportunities, but you should probably not offer advice on personal matters. Often, emotional issues are relevant to one's work, and you can offer moral support, but a good mentor treads carefully.

> *One of the lessons is that my job is not to be their best friend. My job is to be their mentor, and my job is to be their boss or supervisor.… I had this sort of egalitarian thing where I was trying to run a professional laboratory, but I was also wanting to be buddies with everybody.… I have come to realize the alternative—to have a little distance. Things work better if it's clear that I am the head of the lab.*
>
> —Charles Murry, University of Washington School of Medicine

Mentor Versus Adviser

In theory, mentors have multiple responsibilities—being an adviser is one of these. According to The Council of Graduate Schools (http://www.cgsnet.org/) mentors are

- *Advisers:* People with career experience willing to share their knowledge.
- *Supporters:* People who give emotional and moral encouragement.
- *Tutors:* People who give specific feedback on one's performance.
- *Masters:* Employers to whom one is apprenticed.
- *Sponsors:* Sources of information about opportunities and aid in obtaining them.
- *Models of identity:* The kind of person one should be to be an academic.

In reality, it is unlikely that any one individual can fulfill all possible mentoring roles. For this reason, many argue that the term mentor should be used broadly to mean an individual who helps another with one or more aspects of his or her personal or professional development or both. In this sense, trainees are encouraged to seek out various faculty who can provide some of these components.

STRATEGIES FOR EFFECTIVE MENTORING IN YOUR LAB

Make Everything a Learning Opportunity

It helps to think of mentoring as a highly individualized mode of teaching. You want to establish a "culture of teaching" in your lab, so that each individual feels empowered to seek whatever he or she needs to do good science.

Set Specific Goals and Measures of Accomplishment

Work with each individual—at performance evaluation time, in the course of lab meetings, and on other occasions when his or her work is under review—to set specific goals and measures of accomplishment. The following are some examples:

- For a postdoc or student, you might want to establish a publishing goal. It should include deadlines.
- For postdocs, job-hunting goals might be important. You might say, "By next month, give me your list of places you want to apply to. Then we can talk about developing your job talk."
- Have technicians identify new skills they need (e.g., new equipment or software they can learn to use). Give them time to learn and the opportunity to take courses or seek help from others. Then ask them to demonstrate what they have learned at a staff meeting.

In some cases, you may have to push people a bit to set their goals. In other cases, people's goals may be well-defined but may not exactly fit your lab's overall goals. If you can, give them room to explore options, and offer whatever educational and networking opportunities you can afford. Even if they eventually leave your lab to do other things, they will be much happier and more productive while they are with you if they feel you are looking out for them and their future well-being.

Encourage Strategic Thinking and Creativity

Those working in your lab, especially newcomers, may not have the experience to judge how long to struggle with an experiment or a project that is not working. As the principal investigator, you must decide what work is most important, how long a given project can be pursued, and what resources can be allocated to any particular effort. As a mentor, you should explain the basis of your decisions to your trainees. In this way, you give concrete examples of strategic thinking and prepare your trainees for similar decisions they must make when they are in charge of their own research programs.

> *If you just regiment the students' and postdocs' lives, you may have a very productive laboratory, but you may miss out on an opportunity to stumble on a major discovery or new scientific direction.*
>
> —Thomas Cech, HHMI

It is also important to give people enough space to be creative. Don't rush in too quickly with interpretations of data or solutions to problems. Let your staff take the first stab. By doing this, you prepare your trainees to work through projects independently and you benefit from their insights and creativity.

Uphold Professional Standards

Those new to research are still forming their professional standards and habits. They will be working with you for months or years and will learn your lab's way of doing things. Set high standards for yourself and your workers, and make sure your lab offers an encouraging and disciplined environment. Experienced lab leaders list the following essentials:

- Encourage good time-management techniques. At the same time, respect individual patterns of work. (See chapter 6, "Time Management.")
- Clearly state your expectations. Let people know when they are not meeting them.
- Offer criticism in a way that doesn't shame and discourage people.
- Keep abreast of laboratory record keeping. This is a key management responsibility and an aspect of mentoring. As the principal investigator, you are responsible for seeing that your people keep meticulous records documenting their work and meeting regulatory requirements. This habit will serve them well later on. By reviewing lab notebooks frequently, you also guard against falsification of data. (For more on record keeping in the laboratory, see chapter 8, "Data Management and Laboratory Notebooks.")

Impart Skills

Do the following to encourage your lab workers to learn new skills:

- Involve everyone in the scientific publishing and grant-writing process. Part of your job is to teach your trainees how to write publishable scientific papers and successful grant proposals. For papers, have the first author write the first draft, and then send the paper around the lab for review. For proposals, have each person write a piece of the proposal, and then have everyone review successive drafts of the whole package. By doing this, everyone will gain invaluable experience and get a chance to see the big picture of the lab's activities.
- Impart technical skills. As a manager, you need to know the skill sets of each member of your lab and make sure that each important skill is passed on to several people in the laboratory, for their benefit and yours.
- Teach lab management explicitly. Give the people in your lab managerial responsibilities; for example, have them coordinate the sharing of equipment in the lab or draw up a list of routine lab jobs that can be rotated among lab members.

> *I have a graduated system for providing opportunities. For example, [graduate students and postdocs] must write their own meeting abstracts and papers. They must present at lab meetings and seminars in the department when works are published. If they go to meetings, they must provide meeting summary presentations when they get back. If they do well at these tasks, I let them review manuscripts with me, providing comments that I may choose to incorporate into the final review. I may have more senior people review grants with me. The ultimate compliment is when I ask them to attend meetings on my behalf.*
>
> —Milton Datta, Medical College of Wisconsin

Provide Networking Opportunities

One of the most important benefits you confer on the people you train is admission to the network of scientists in your field. Your reputation opens doors for those associated with you, and the connections are not likely to be made without your involvement. So take steps to facilitate the introductions, including

- Allowing trainees to meet with seminar speakers invited to your institution
- Taking trainees with you to meetings and introducing them to your colleagues
- Encouraging trainees to approach your colleagues about scientific matters, using your name
- Encouraging trainees to make presentations at meetings when they are ready

Give Moral Support

You can help the people you mentor estimate their own potential and chart their life course. To do so, you must be supportive and honest. Try to convey to each of your trainees that you have a commitment to him or her and that when a problem surfaces, you have an interest in helping to solve it and will do everything you can to do so.

DIFFERENT MENTORING NEEDS

Each type of lab worker—for example, undergraduate, graduate student, postdoc, and technician—is on a different professional trajectory. As you work with them, you need to keep in mind their path and their location on that path.

Mentoring Undergraduates

The seeds of a scientific career are planted in the undergraduate years or even earlier. Promising undergraduates can be invited to take part in research through academic independent-study options or can be given paid work. Take their work seriously, and set high standards for them. You might place them under the day-to-day guidance of a graduate student or postdoc, but you should maintain a strong role in overseeing their training and the overall flow of their work within the lab. Keep in mind that these beginning researchers may need extra encouragement when their research isn't going smoothly.

Mentoring Graduate Students

In science as in other fields, graduate school is vastly different from the undergraduate scene. Perhaps the most important difference is that undergraduates are expected to be primarily engaged in absorbing knowledge, whereas graduate students are expected to begin making their own contributions. A mentor helps new graduate students make this transition. A graduate student may have several mentors, but the most important is the principal investigator in whose lab the student is working.

A typical graduate student follows this trajectory:

First years. The principal investigator's task is to provide a focus—a coherent plan of study. The student faces a steep learning curve. Basic techniques must be learned, comprehensive exams taken, and a thesis topic chosen. The principal investigator keeps tabs on the student's progress. The student's success depends on effective mentoring by the principal investigator.

Middle years. At some time during these years, the student may be struggling with his or her thesis. The principal investigator helps the student out of a slump by offering moral support and suggesting ways to tackle a scientific problem. By now, the student has learned a lot and should be sharing information and techniques with colleagues, younger students, and postdocs. Teaching others is a good way to learn.

Final years. The student is preparing to move on. The thesis should be near completion, and the search for a postdoctoral position should be under way. The principal investigator will be asked for letters of reference and perhaps more active job-hunting assistance. Other mentors, such as members of the thesis advisory committee, may be called upon for help in the job search as well.

Mentoring Postdoctoral Fellows

Postdocs are hybrid creatures. On the one hand, they are highly trained professional scientists who are working in your lab for a limited time to conduct research within the general parameters of your interests. On the other hand, they are not really complete professionally, because a stint as a postdoc is usually a prerequisite for an academic position. Your task as a mentor of postdocs is therefore complex.

Keep in mind that the amount of time you can spend helping your postdocs will be limited, so use that time efficiently. In addition, find ways to have them help one another or obtain assistance from other sources.

You must strike a delicate balance in directing postdoctoral work. Although the postdocs are helping you with your projects, you must treat them as collaborators, not employees who require close supervision. Encourage them and give them the help they need, but give them sufficient independence so that they "own" their projects.

You do have a protective function when it comes to the politics of the larger academic world. Your postdocs are young, politically inexperienced, and vulnerable. You need to be aware of outside competition. Be prepared to steer your postdocs away from projects that might result in conflict with researchers who are already working on similar projects and who might publish results before your postdocs are able to.

If a postdoc is not working out as you had hoped, encourage him or her to make a change. You may be able to help the postdoc find a more suitable position. But even if you can't, an unhappy postdoc should move on sooner rather than later. (See "Asking Staff to Leave," page 75 in chapter 4, "Staffing Your Laboratory.")

As with all trainees, it is important to discuss career goals with your postdocs. Not all will be interested in or competitive for academic positions. For those who are, give them a project that they can take with them after they leave your lab to help them establish their own labs. Alternatively, you can let your postdocs take a project with them and work on it for a specified time period (e.g., for several years) without competition from you, with the understanding that when that period has passed, your lab may pursue research in the same area.

You have a huge role to play in facilitating your postdocs' job hunts. Keep alert to job openings, counsel them about the process, coach them in their interview presentations, and give them the best letter of recommendation you can. Sometimes, when the search doesn't go smoothly, you may need to keep them in your lab a little longer than you expected. Keep up the words of encouragement during this difficult period.

After they have gone, keep in touch with them. They will be an increasingly important part of your professional network.

Mentoring Physician-Scientists

Physician-scientists have an especially complicated balancing act: caring for patients, maintaining a productive research lab, and meeting regulatory requirements for human-subjects research. As a result, they must closely protect their research time.

As a mentor, you should understand the unique challenges physician-scientists face. If you have worked in this environment, you can help with establishing priorities and with effective time management. In addition, you can also help the young physician-scientist acquire the necessary political and diplomatic skills and help convince clinician colleagues of the value of research in general.

Mentoring Technicians

A technician is your employee, hired to get work done. That being said, many technicians are a distinct type of professional scientist. You should understand and encourage their aspirations. Make it clear to them that they are valued contributors to your projects. If they are interested, you may want to give them research projects of their own. If their aspirations are purely technical, encourage them to gain new skills.

MENTORING INDIVIDUALS OUTSIDE YOUR LAB

When you get a request for mentoring from a young scientist in another lab, or even in another university, think carefully before you agree. On the one hand, the request says something positive about your standing in the research community. In addition, by taking on a new relationship, you might open up the possibility of future collaborations. On the other hand, there may be problems you are not aware of. Ask yourself the following questions:

- Why is this person asking me for help? There may be a negative reason. In the case of a postdoc, perhaps he or she is dissatisfied with relationships in the home lab. If this is the case, make sure you are not offending the individual's principal investigator. Do not enter into such a relationship secretly. Insist that the postdoc inform his or her principal investigator that you two are speaking. You may find that the other principal investigator welcomes your help as an extra resource.
- What are the person's expectations? You need to be clear about whether you are being asked for occasional advice or long-term assistance. If it's the latter, determine whether your mentoring role will be formal or informal.
- Do I really have the time and energy to commit to this relationship?
- Is this someone I want to mentor?

The people in your lab deserve priority. But if the person fits, and you can extend yourself, do so.

HOW TO GET THE MENTORING YOU NEED

Being mentored is as much an art as mentoring. It's a matter of getting plugged in to a complex network, knowing whom to ask for what, knowing how to accept the professional advice you receive, and maintaining long-term personal and professional relationships. The following suggestions may help:

- Don't let go of your old mentors. Stay in close touch with your graduate and postdoc advisers. Although they may not be familiar with your new environment, their distance from it, combined with their general understanding of the world of science, can help you put your current environment in perspective. Also, you never know when you will need to ask them for a reference or other professional help. Even a quick e-mail to let them know that you published a paper or received a research grant or an award will help them support your career.

- Establish a relationship with a set of official mentors. Your new department probably will assign you a mentor or even a mentoring committee. These individuals may ultimately constitute your promotion and tenure committee, so cultivate them carefully and treat them with respect. You do not want to vent your frustrations or confide your uncertainties and weaknesses to this group.
- Seek out informal mentors. These usually are experienced scientists within your department or elsewhere who can give you a broader perspective on science and scientific politics. It is especially important to do this if your department has not assigned you an official mentor.
- Establish a set of confidants. These are people with whom you can openly share information about politically sensitive issues. Choose them carefully. You may be more comfortable limiting your confidants to one-on-one relationships. Or you may find a group that puts you in close touch with colleagues whose situations are similar to yours.
- Meet regularly with your formal mentors. Keep them apprised of your progress. Do not avoid them if things are going badly. Enlist their help.
- Keep meetings professional. Respect your mentors' time constraints. Be specific about what you ask for.

How to Be Mentored Well

Here are some qualities to cultivate in yourself as you seek to be mentored:

- *Foresight:* Start early to think about your future.
- *Proactivity:* Don't expect to be taken care of. You could easily be overlooked in the competitive world of science.
- *Probing:* Ask tough questions. Find out about the experiences of others with this potential mentor.
- *Respect:* Be polite. Make and keep appointments. Stay focused. Don't overstay your welcome.
- *Gratitude:* Everyone likes to be thanked.
- *Reciprocation:* Repay your mentor indirectly by helping others.
- *Humility:* Be willing to accept critical feedback so that you are open to learning new ways of thinking about and doing science.

When the Relationship Is Not Working Out

Consider finding another mentor if yours is clearly and consistently uninterested in you, undervalues your abilities, or displays any other signs of undermining the relationship. Consider finding another mentor if yours behaves inappropriately by violating workplace rules or fails to fulfill essential responsibilities to you—for example, by not sending letters of reference or by not reviewing your work. You may need to appeal to whatever conflict-resolution mechanism exists at your university. Start with the human resources office for guidance on how to proceed.

However, be careful about changing mentors. Even if the relationship is not going well, you do not want to offend someone unnecessarily. If the relationship is official, ending it will require explicit action and most probably generate bad feeling. If the relationship is informal, and you can just allow it to peter out, do so. If your mentor wants to terminate the relationship, accept the decision with good grace. It will be better for both of you.

GENDER AND CULTURE ISSUES

You want to treat everyone fairly, and you want to keep scientific merit in the forefront in your judgments about the postdocs, students, and others you mentor. You want to be treated the same way yourself. You should work very hard to ensure that differences in gender, race, economic resources, and degree of comfort with the English language and with U.S. customs do not affect your mentoring relationships.

Gender Issues

As you embark on mentoring relationships involving women scientists and pursue your own career, consider the following:

- Early in their careers, many women scientists may be in need of role models in their profession. If you are a woman, and you are making good progress on a career in science, younger women may want to know how you do it. If you have had failures, or are making compromises, they may want to know that too. You may want to share your experiences, positive or negative, with the next generation.
- If you are a successful woman scientist, you may be called upon too often to serve on committees as the representative of your gender. Do what you can, but be selective and don't let committee work get in the way of your research.
- If you are directing a young scientist—woman or man—part of your goal should be to help her or him remove unnecessary barriers to success. So do what you can to accommodate family responsibilities.

Cultural Differences

You are very likely to find yourself the mentor of students from other countries, or from minority groups within the United States. Language and cultural differences may make the mentoring relationship more challenging. For example, people from some cultures may convey information only in indirect ways, or they may be reluctant to argue with an authority figure. As a mentor, it is important to be aware of cultural differences when dealing with issues in the lab. Most campuses have resources to help foreign students become acculturated; encourage the people in your lab to get whatever aid they may need.

RESOURCES

American Association for the Advancement of Science. *Science*'s Next Wave. Feature articles on mentoring, http://www.nextwave.org.

Association for Women in Science. *Mentoring Means Future Scientists: A Guide to Developing Mentoring Programs Based on the AWIS Mentoring Program*. Washington, DC: Association for Women in Science, 1993.

Barker, Kathy. *At the Helm: A Laboratory Navigator.* Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press, 2002.

Fort, Catherine C., Stephanie J. Bird, and Catherine J. Didion, eds. *A Hand Up: Women Mentoring Women in Science*. 2nd ed. Washington, DC: Association for Women in Science, 1995.

HMS Beagle (now *BioMedNet Magazine*). Articles on mentoring, http://news.bmn.com/hmsbeagle/.

National Academy of Sciences, National Research Council. Reports from the Committee on Science, Engineering, and Public Policy, http://www7.nationalacademies.org/cosepup.

National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. Committee on Science, Engineering, and Public Policy. *Adviser, Teacher, Role Model, Friend: On Being a Mentor to Students in Science and Engineering*. Washington DC: National Academy Press, 1997, http://search.nap.edu/readingroom/books/mentor/.

National Institutes of Health, Office of the Director. *A Guide to Training and Mentoring in the Intramural Research Program at NIH*. Bethesda, MD: National Institutes of Health, 2002, http://www1.od.nih.gov/oir/sourcebook/ethic-conduct/TrainingMentoringGuide_7.3.02.pdf.

Nyquist, Jody D., and Donald H. Wulff. *Working Effectively with Graduate Assistants*. Thousand Oaks, CA: Sage Publications, 1996.

Reis, Richard M. *Tomorrow's Professor: Preparing for Academic Careers in Science and Engineering*. New York: IEEE Press, 1997.

University of Michigan, Horace H. Rackham School of Graduate Studies. *How to Mentor Graduate Students: A Guide for Faculty at a Diverse University*. Ann Arbor, MI: University of Michigan, 2002, http://www.rackham.umich.edu/StudentInfo/Publications/FacultyMentoring/contents.html.

Chapter 6

TIME MANAGEMENT

This chapter is based on the session "Time Management" that was held at the BWF-HHMI Course in Scientific Management. The session was organized by Maryrose E. Franko, Ph.D., Howard Hughes Medical Institute (HHMI), with presentations by Todd Golub, M.D., Dana-Farber Cancer Institute (also HHMI associate investigator); Richard M. Reis, Ph.D., Stanford University; and Sandra L. Schmid, Ph.D., The Scripps Research Institute. Additional information was obtained from Milton W. Datta, M.D., Medical College of Wisconsin, and some of the resources noted in this chapter.

From a practical perspective, one of the most daunting challenges for beginning investigators is learning how to cram an impossible load of new obligations into a 24-hour day. Finding ways to manage the conflicting demands on your time can be the key to developing a successful career and a rewarding personal life. This chapter discusses planning strategies that are critical for successful time management, such as defining long- and short-term goals and making choices. Tips for day-to-day time management are also presented. The chapter also offers guidance on managing committee service commitments, balancing research and teaching, and juggling the demands of home and work. In addition, it covers issues specific to physician-scientists.

STRATEGIES FOR PLANNING YOUR ACTIVITIES

Defining Goals

Planning is a process that begins with a goal. Once you have set a goal, you can identify the necessary steps to move toward it. Goals come in descending sizes, each of which informs the next: long-term goals (years), intermediate-term goals (months), and short-term goals (weeks and days).

Long-term goals are likely to be a combination of tangibles (e.g., faculty promotions) and intangibles (e.g., a satisfying personal life) that may change over time, making goal setting an ongoing process that you should revisit periodically. In defining your long-term goals, you are also defining yourself—who you want to be and how you want to be perceived.

Intermediate-term goals, such as publishing a paper, are often composed of many short-term objectives, such as preparing figures for a paper. Short-term goals are the ones written on your weekly and monthly calendars—the small, concrete, finite tasks that can swallow your time.

Getting from Here to There

Take the time to craft a formal plan, beginning with your long-term goals. Then set interim goals along the way that are realistic indicators of progress. By setting achievable goals, you avoid having too much to do and not knowing where to begin. Accomplishing just one goal can serve as a powerful motivator to tackle the next goal.

> *The key is to identify what matters to you in terms of interests and values and then to apportion your activities throughout the day and week to address all of them.*
>
> —Richard Reis, Stanford University

Write down all your goals, with each achievement tied to a specific time frame. Putting your ideas into words can help refine your thinking and provide a concrete checklist to keep you on target. Every so often, take a look at your plans, reflect on them, and revise them as appropriate to changing circumstances. Priorities shift; be prepared to reevaluate yours but also to defend them.

Long-term goals. These goals can be achieved in three to five years. Before jotting down your long-term plans, first ask yourself where you want to be after this stage in your career. For example, if you are a postdoc, do you plan on an academic or applied position? At what type of institution—a research-intensive institution, teaching college, other? Now ask yourself, "What will I need to accomplish to make myself competitive for that job?" If you are an assistant professor, you probably want to work toward tenure. Knowing when you'll be up for tenure, ask yourself, "What will I need to do by then—how many papers, invited seminars, professional meetings, and other accomplishments?"

Intermediate-term goals. These goals can be achieved in six months to one year. For example, as a postdoc you should be thinking about the experiments needed to complete your next paper or to put together a poster. Completing publishable chunks is an essential intermediate-term goal for faculty. Other such goals are obtaining preliminary results for a grant, putting together a new course, and organizing a meeting.

Short-term goals. These goals can be achieved in one week to one month. They include preparing figures for the paper you're writing, completing an experiment, preparing reagents for the next set of experiments, or writing letters and making phone calls to secure a seminar invitation. If you find it hard to get organized, make a daily or weekly to-do list and check tasks off as you complete them.

Making Choices

Saying no, saying yes. One of the simplest things you can do to streamline your life is, for many people, also one of the hardest: Learn to say no. Remember, you can't do everything, please everyone, be available to everyone, and at the same time be an ideal teacher and scholar. There are certain tasks you must say no to and others for which it's fine to deliver a less than stellar performance. Making such choices will allow you to focus on doing an outstanding job in what's truly important to you. Establishing these priorities depends on the intermediate- and long-term goals you have set for yourself.

Saying yes judiciously will make it easier for you to say no to things you do not want to do. Because you must accept some administrative assignments, try to make them work for you. Explore the options, and sign up early for duties that either interest you or will work to your advantage professionally. This will then allow you to turn down administrative duties that have less value to you.

Disconnecting. Part of saying no is also not being available on demand. Today's technological "conveniences" are often needless interruptions to concentration. Any sound strategy for time management involves learning to disconnect—be the master of those tools rather than their servant.

MANAGING YOUR TIME DAY TO DAY

Many people find long-term goals easy to set—for example, "I want to be a full professor by the age of X." More difficult is the daily multitasking—managing the flood of small chores that can threaten to drown even the most organized professional. This section covers how to make the most of the time you have.

Seven (Not So Obvious) Keys to Working and Living Right

1. Learn how to say yes as well as how to say no. It's easier to say no to unwanted tasks if you have already committed to something you do want to do.
2. Establish your absence as well as your presence. Set a schedule for being physically elsewhere and unavailable, and stick to it.
3. Do a little bit of everything as well as all of one thing. Master the art of multitasking.
4. Determine your tasks as well as your priorities. There are many activities, small and large, that lead to your goal.
5. Work until your time is up as well as until your task is done. Approach every task with the goal of making progress during a specific amount of time, then move on to the next task to maintain forward momentum.
6. Bring some of your home to work as well as some of your work to home. You live in both worlds; look for ways to bring them together (e.g., if you have a long commute, leave home early to beat the traffic and save breakfast and the newspaper for your office).
7. Seek to integrate your professional and personal activities where appropriate as well as to separate work and play where appropriate. Doing so can maximize your effectiveness and satisfaction in both areas.

Source: Richard M. Reis, Stanford University

Finding Some Extra Time

To be able to focus and think creatively, you need blocks of uninterrupted time. Here are some tips to help you do this:

- Get your e-mail under control. If you're lucky enough to have administrative help, have an assistant screen messages and flag time-sensitive ones for you. You can also print e-mail messages that require a personal reply and hand write responses during short breaks in your day. Then have your assistant type and send them later. If you don't have an assistant, set aside specific times of the day for reading and responding to e-mails or take hard copies of your e-mails home and read them in the evening.
- Buy an answering machine or voice-mail service.
- Invest in a family cell phone plan to make sure you're available for family communication and emergencies when you have silenced your office phone.

- Close your office door (or come in early). A closed door is a generally respected "do not interrupt" signal, and early hours might buy you precious focused time away from clamoring students and colleagues.
- Close your lab door. Securing uninterrupted time in the lab is of paramount importance to your career.
- Make, and keep, appointments with yourself: Find a quiet hideaway and use it on a scheduled basis. This practice trains people to expect you to be inaccessible at predictable times.

Having Trouble Concentrating?

If you tend to have difficulty focusing on one task for long periods, you can turn this potential weakness into a strength through multitasking. Make sure that you always have several things to work on, perhaps three or four, and cycle through them with increasing lengths of time. Because it allows you to make progress simultaneously on multiple tasks, this approach can help you

- Reduce stress as deadlines approach because the work is well along
- Make headway on necessary tasks you don't want to do
- Improve your sense of accomplishment and control over your workload

Setting Priorities

On the basis of your goals, decide what you need to do and when, and follow the classic KISS rule: Keep It Simple, Stupid. A grid that allows you to rank short-term claims on your attention according to urgency and importance can be a useful tool (see figure 6.1). Try to control the not urgent/not important quadrant. You get relatively little value for the time spent doing tasks in this quadrant. The urgent/important quadrant puts you in crisis mode, where few people operate best. For maximum efficiency, you should be spending most of your time in the upper right-hand quadrant on tasks that are important but not urgent.

Figure 6.1. Time management grid

	Not Important	**Important**
Not Urgent	• Most e-mail • Weekend plans of lab members • The Super Bowl pool	• Ongoing experiments • Preparing for a committee meeting • Next month's grant deadline
Urgent	• "You've got mail" alert • Ringing telephone • Inquiring colleague	• A lab fire • Tomorrow's grant deadline

Source: Sandra L. Schmid, The Scripps Research Institute, adapted from Stephen R. Covey's time management matrix in *The Seven Habits of Highly Effective People: Powerful Lessons in Personal Change*

If it's important but not urgent, remember your priorities and schedules:

- Plan ahead and know your deadlines.
- Set aside blocks of time for specific tasks.
- Break large tasks into smaller tasks.
- Delegate tasks.
- Complete tasks on time.

Making the Most of the Time You Have

It's important to find ways to make efficient and productive use of your time. Be aware that for some activities, it may not be immediately apparent that your time spent is worthwhile. For example, attending seminars in your department can actually be a productive and efficient use of your time. Not only will you learn new information, but if you ask questions, you will also boost your visibility.

Efficiency. Successful people tend to be efficient. They have evolved practices to create blocks of uninterrupted time for "brain work." Here are some tips to help you make the best use of those parts of the day you control:

- Create an environment conducive to productivity. Make a place for everything, and put everything in its place; clutter is inefficient. Find or make a quiet space (or time) to work.
- Know your biological clock, and protect your most productive hours for your experiments and critical tasks.
- During your protected work hours, focus and don't allow interruptions.
- Eliminate unnecessary tasks.
- Avoid procrastination. Start tasks early—at least in outline. If you have a grant due, write your goals early enough to let your lab staff start gathering relevant data without last-minute panic. If a critical reagent requires a long lead time to produce, start it early enough to make sure it's ready when you need it.
- Structure and supervise meetings.
- Delegate work.
- Get a high-speed Internet connection at home.

Question: How do I resolve the competing demands of doing my own bench work versus guiding the work of postdocs and lab staff?

Answer: Focus on what you're uniquely qualified to do. That usually includes mentorship and scientific management; just about everything else can be done well by others. Until you have good postdocs and trained students and technicians, you'll have to do more work yourself. But as your lab evolves, you'll have more freedom to decide the ways in which you will trust your lab members to carry out your research agenda.

> *Having a high-speed Internet connection at home has revolutionized our lives. I can be home at 5:00, put the kids to bed, get on the PC, and do everything from home. It has really improved our parenting and family abilities with more efficient time management.*
>
> —Milton Datta, Medical College of Wisconsin

Fitting it all in. Successful people also learn to use small units of time, capitalizing on free minutes here and there (in many professions, people bill their time in increments of 15 minutes or less). Returning phone calls, drafting memos, and reviewing your weekly schedule are just a few ways in which you can put a few minutes to work for you throughout the day. The trick is to be prepared when those moments arise by having messages or e-mail, students' homework, a notepad, and perhaps a cell phone with you. Some tasks, such as reviewing papers and reading science magazines, adapt well to commuting time if you don't drive.

> *Be prepared to take advantage of small chunks of time. In 5 to 10 minutes, you can make a quick phone call, handle an e-mail requiring a personal response, or fill out a form.*
>
> —Sandra Schmid, The Scripps Research Institute

Improving Your Lab Staff's Time Management Skills

Here are some tips for helping your staff work more efficiently:

- Establish clear goals and expectations early, starting with simple tasks your staff can handle. Make sure they understand the task. Reward and correct them as appropriate, expand the tasks, then repeat the process.
- Help them seek advice without taking up unnecessary time. Teach them how to describe projects, issues, and problems accurately and efficiently.
- Develop an agenda for every meeting—and stick to it. Start meetings with a clear description of the purpose of the meeting and when it will end.
- After meetings, send a "Dear gang" follow-up letter containing a summary and to-do list. Use these informal minutes to start the next meeting and gauge progress. (Meeting minutes are also useful for patent protections in establishing proof of an idea, attribution, and date.)

Once the members of your lab learn the importance of time management, you can also delegate to a key staffperson the task of summarizing meetings and assigning follow-up actions.

> *Investment of time to train others does pay off in time efficiencies.*
>
> —Richard Reis, Stanford University

> *When your lab members report to you on a project, request that they first provide some context and then organize what they tell you in concise bullet points of information: "I'm going to tell you about this morning's experiment. This was the result. This is what I think it means. This is what I plan to do tomorrow." With this strategy, a five-minute interaction can get you immediately connected to what the person is doing.*
>
> —Todd Golub, HHMI and Dana-Farber Cancer Institute

SPECIAL ISSUES

Managing Committee Service Commitments

Committee duties can connect you with interesting people—in your department, your institution, and beyond. They can also help bring your research to the attention of your colleagues—a genuine plus for a beginning faculty member.

But how can you avoid spreading yourself thin with committee service obligations? Be proactive and seek out committee service that suits your interests and schedule so you can turn down other requests with the legitimate excuse of previous committee commitments. Women and underrepresented minorities need to be particularly good at saying no because they're frequently asked to serve on committees.

> *Try to volunteer for something that you care about or that would benefit you. For example, the graduate admissions committee is often of great interest to a starting assistant professor. Then use these commitments as a reason to decline other opportunities for committee work that come along. So the next time someone comes and tells you about this great committee that they would like you to sit on, say, "I would really love to do that, but it turns out I just agreed to do this huge graduate admissions committee job. It's going to be very time-consuming and it's so important." And then they will nod understandingly and, hopefully, walk out the door and not ask you again.*
>
> —Thomas Cech, HHMI

Research and Teaching

If you're in a department that values good teaching and you're thinking about tenure, if you want your course material to be up to date and engaging, or if you are responsible for difficult material you don't fully understand, you may find yourself dedicating a large portion of your time to teaching at the expense of everything else. For the sake of your research career, you must learn to control your class-related hours. How can you do this? HHMI President Thomas Cech, recounts the method he used while on the faculty of the University of Colorado–Boulder, which can be summed up as "limit your preparation time":

> *If I had a 10:00 a.m. class, I would start preparing three or four hours before, and whatever I got done in those hours, that was it. I couldn't solve all of the problems with my lecture, but spending more time wasn't going to make the lecture that much better. And after 11:00, I had the rest of the day for my research.*

As your classroom experience and confidence grow, you can whittle down preparation time. Another approach is to schedule a 30-minute appointment with a local expert on the subject that you have to teach before you teach it.

Other tips for controlling preparation and classroom time include

- Admit your ignorance. When you can't answer a question, it's perfectly permissible to say so. In fact, it's far better than trying to fudge an answer. Instead, acknowledge that it's a good question, you don't know the answer, and you'll check it out. Or ask the student to find the answer and report back to the class.
- Triage the information for your students. You can't know every subject exhaustively and don't need to; neither do your students. Clarify what you expect them to learn, and focus your lectures on that information. Focusing on the really important "take-home points" limits your preparation time and their questions.
- Arrange to teach the same course for three consecutive years. That span will permit you to refine the material and your technique without burning out.

Even though it is difficult, you have to set limits for nonresearch tasks and stick to them. When time is up for one task, move on to the next item in your daily planner. This way, you start each day anew without carrying forward serious work deficits that accumulate throughout the week. As a guideline, one senior scientist advises that regardless of how much office work you have, as a beginning principal investigator, you should be spending the equivalent of at least two full days in the laboratory every week.

The Triple Load of the Physician-Scientist: Lab, Class, and Clinic

Although physician-scientists may have some teaching duties, these duties usually aren't extensive. The larger challenge is balancing lab and clinical time. An even split between the lab and clinic is increasingly rare; it can be as much as 80 percent lab and 20 percent clinic. Here are some tips for straddling the lab and the clinic.

In the lab:

- Get help early.
- Separate lab management from scientific management and mentorship. If possible, hire someone interested in and trained for lab management.
- Focus on what you're uniquely qualified to do.
- Focus on what you're actually *trained* to do.

In the clinic:

- Tell patients how you want to be contacted.
- Use support staff effectively.
- Learn to tell patients when you have to stop.
- Make patients and colleagues aware of your dual roles.

Remember, in the lab, in the clinic, and at home—don't suffer in silence. If a patient's poor condition affects your mood and concentration, tell your colleagues and family. Patients care is a major responsibility, and it's reasonable for your clinical care time to affect other aspects of your life.

Home and Work: Can You Have It All?

This question applies to many professionals in high-pressure careers, including both male and female scientists pursuing academic career tracks.

Family communication. It helps to start with a supportive spouse and family. Have clear discussions about career and personal goals—yours and those of your family—early on. To avoid the resentments of unspoken and unmet expectations, be as explicit as possible about your aspirations with those who are important to you. Shared goals for work and family make compromises easier.

Balancing work and family. Unquestionably, children complicate the equation, but they can also provide the sanity, personal satisfaction, and motivation to make you a more focused and efficient scientist. Few professionals are willing to forgo having children in order to facilitate career advancement, nor should they. High-quality day care, domestic services, shopping conveniences, etc., make raising a family and having a challenging career sustainable and enriching. Indeed, being the boss (i.e., running a lab) can give you the flexibility and the financial resources to make the choices and time commitment adjustments necessary to maintain a balanced lifestyle. Here are some tips for balancing work and family life:

- Take advantage of options for assistance in cooking, cleaning, and other domestic chores, and don't waste energy feeling guilty. When your budget allows (and in the early years, it may not), buy yourself time: Hire help with housecleaning—even if you can afford only semimonthly scouring of the bathrooms and kitchen. Until then, a messy (but reasonably clean) house won't hurt you or the kids. Later, a nanny or housekeeper (who also does laundry) is worth the investment.

- Eat out with your family once a week or once in a while, even if it's fast food. This is an easy family-focused activity you can enjoy together outside the house.
- Pick up carryout meals to eat at home. This break from cooking will stretch the dinner table time you have to share information about everyone's day and allow you to play with younger children and put them to bed.
- Teach your children how to help out with age-appropriate chores (e.g., putting their clothes in a hamper, putting away clean laundry, setting the table).
- When you do cook, keep meals simple and make large quantities that can be frozen in meal-size portions for use throughout the week.
- If you and your spouse both work outside the house, make the best child-care arrangements you can. If you're away from your child all day, it's especially important to carve out inviolable family time on evenings or weekends.

> *I don't sell cookies or gift wrap for my kids' school; I write checks. I don't volunteer in their classrooms; I go on one field trip a year, which means a lot to my kids. My family takes a two-week summer vacation, a trip at spring break, and long weekends away.*
>
> —Sandra Schmid, The Scripps Research Institute

Is it possible for ambitious scientists to have it all? For those who learn to balance competing demands, the answer is a qualified yes. The key—admittedly easier said than done—is to identify what matters most to you and then to apportion your activities throughout the day and week to address them all. The important thing is to set your priorities, learn to compromise, and be flexible.

RESOURCES

Blanchard, Kenneth H., and Spencer Johnson. *The One Minute Manager*. 10th ed. New York: Berkeley Books, 1983.

Boice, Robert. *The New Faculty Member: Supporting and Fostering Professional Development*. San Francisco: Jossey-Bass, 1992.

Covey, Stephen R. *The Seven Habits of Highly Effective People: Powerful Lessons in Personal Change.* New York: Fireside, Simon & Schuster, 1990.

Reis, Richard M. *Tomorrow's Professor: Preparing for Academic Careers in Science and Engineering*. New York: IEEE Press, 1997.

Chapter 7

PROJECT MANAGEMENT

This chapter is based on the session "Project Management" that was held at the BWF-HHMI Course in Scientific Management. The session was organized by Jim Austin, Ph.D., American Association for the Advancement of Science, and presented by Stanley E. Portny, Stanley E. Portny and Associates. Milton W. Datta, M.D., Medical College of Wisconsin, provided the scientific examples to illustrate how project management tools are used to plan and track research projects. Additional information was obtained from some of the resources noted in this chapter.

Project management, a concept long familiar to the business world, has a place in the research community as well. Although new faculty may be inclined to dismiss the strategies of project management as irrelevant to the scientific process and antithetical to creativity, these strategies can help you reduce wasted effort, track progress (or lack of it), and respond quickly to deviations from important aims. This chapter explains the tools of project management, why it is worth your while to master them, and how they can help increase productivity in your lab.

WHAT IS PROJECT MANAGEMENT AND WHY IS IT IMPORTANT?

At a basic level, project management is a form of oversight—planning and supervising an activity from start to finish with the aid of graphs, charts, and procedures often implemented through a software package. It is a constant learning process, a series of flexible and iterative steps through which you identify where you want to go and a reasonable way to get there, with specifics of who will do what and when along the way.

Project management techniques are not blinders to limit your focus, nor are they meant to change your work style. Rather, they enable you to understand and work effectively within, or around, that style.

If you find the business-oriented terminology and tools of project management off-putting, here's a tip that may be helpful: The steps of project management are similar to the components of a grant proposal. (See chapter 9, "Getting Funded.") With a grant proposal, the probability of success is proportional to the thought that's gone into it. The funder wants to see that you've thought things through. Project management is simply another name for that process.

> *A detailed, well-designed project plan is one of the sharpest tools available for convincing a funder, such as NSF or NIH, to give you the resources you require.*
>
> —Stan Portny, Stanley E. Portny and Associates

GETTING STARTED

Projects run the gamut from simple to complex, from informal to formal, and from familiar to novel. Every project starts with two questions: "Should I do it?" and "Can I do it?" Once you've determined that the project is both desirable (its potential benefits outweigh its projected costs) and feasible, you then follow the three basic steps of project management:

- *Planning:* Develop a statement of work, define the audience, develop a work breakdown structure, schedule the project, and estimate resources.
- *Organizing:* Assign tasks and responsibilities.
- *Controlling:* Monitor, review, revise as appropriate, communicate, and manage risk.

The next sections focus on these steps. Questions you should ask and tools to help you answer them are included, as well as real-life examples of how these questions and tools are used to plan and track a scientific project.

PLANNING THE PROJECT

Develop the Statement of Work

Think of a project as a journey. From a known starting point to a desired destination, you map out details of the trip—which, for your purposes, may not necessarily be the fastest or most direct route. In project management parlance, your trip planner is the statement of work, and everything else flows from it. The statement of work should include the following sections:

Purpose. This section should include

- *Background:* Why the project was initiated and by whom, what happens if it's not done, and what else relates to it.
- *Scope of work:* What you will do—a brief statement describing the major work to be performed.
- *Strategy:* How you plan to perform the work.

Objectives. Objectives are the end results to be achieved by the project. Each objective should include

- *Statement:* A description of the desired outcome when the project is done.

Question: Isn't it possible that a full understanding up front of the scope of work involved may discourage us from trying and accomplishing worthwhile work?

Answer: The goal is to allocate resources in a sensible way. The more information you have at the outset, the better you'll be at allocating resources. The better you are at allocating resources for the work that has to get done (e.g., the experiments proposed in your funded grant), the more likely you will be able to save some funds for more speculative projects (e.g., an interesting side project that may result in a new grant).

Question: Given the uncertainties in science, is it possible to reassess and redefine goals?

Answer: Absolutely. Project management isn't meant to be rigid or blindly restrictive. Indeed, by systematizing the regular reexamination of goals and circumstances, project management encourages reconsideration of which path is best.

- *Measures:* Indicators to assess how well you have achieved the desired outcome.
- *Specifications:* Target values of the measures that define successful results.

Constraints. These are the restrictions on the project, which fall into two categories: limitations and needs. Limitations are constraints set by others, and needs are constraints set by the project team.

Assumptions. These are the unknowns you posit in developing the plan—statements about uncertain information you will take as fact as you conceive, plan, and perform the project (e.g., you may assume that no one will leave the project before a certain milestone is reached).

Be aware that as your project progresses, your goals may change. Build in periodic reviews of results against objectives and revise the objectives if necessary. No matter how much you've invested in a project, it's never too late to redirect or stop work altogether if you discover, for example, that another route is more promising than the main avenue of research, an important calculation was botched, or a key premise was off base.

Define the Audience

Any of your audiences—the people and groups that have an interest in your project, are affected by it, or are needed to support it—can sink the entire enterprise if not considered at suitable stages. Early on, you should make a list of the project's audiences, both within your institution and outside it. Although you can do this in your head, a written list serves as a reminder throughout the project to touch base with these people as you proceed. When you are writing a grant, creating an audience list focuses your attention on these key players and helps you shape strategies to keep them happy and accommodate their needs. The same principles apply to other types of projects.

Divide your audience list into three categories:

- *Drivers:* People who tell you what to do, defining to some degree what your project will produce and what constitutes success. As a principal investigator, you are the main driver for your research. Additional drivers might include other scientists working in the field, the editors of scientific journals (e.g., if they are advising you on what experiments should be done in order to get a manuscript published), and the study section reviewers of the research grants (e.g., if their feedback is shaping the course of your research project).

Statement of Work: A Real-Life Example

Section 1: Purpose

Background. Theresa, a postdoc in the laboratory, wants to examine the possible role of Sumacan in prostate cancer. She noted that Sumacan, a growth factor receptor gene that our lab is studying, maps to a genetic region involved in human prostate cancer. Current studies in the lab focus on the role of Sumacan in brain tumors. Bob, a postdoc, is examining drugs to block Sumacan function; Ming Li, a graduate student, is working on elucidating the Sumacan functional pathway; and Steve, a graduate student, is performing a mutational analysis of the Sumacan gene. These studies can be extended to prostate cancer, thereby opening up new avenues for funding through prostate cancer foundations.

Scope of work

- Demonstrate that the functional pathway for Sumacan is present in human prostate cancer cells.
- Examine the expression of Sumacan in human prostate tissues and prostate cancers, and correlate expression levels with clinical outcome in prostate cancer.
- Identify mutations in Sumacan in patients with prostate cancer.

Strategy. Each person in the lab is already working on different aspects of Sumacan biology in brain tumors. In each case, the work will be translated to prostate cancer cell lines that we will obtain from Mike, a colleague in our department. In addition, we have identified two potential collaborators—Rajiv, a pathologist who studies human prostate tissues and cancers, and Kathy, a geneticist who studies human prostate cancer families, who will help us examine the role of Sumacan in human prostate cancer.

Using our preliminary findings, we aim to obtain National Institutes of Health (NIH) funding for this project, which would provide a second R01 grant to the laboratory.

Section 2: Objectives

Statement. Investigate the possible role of Sumacan in prostate cancer.

Measures

1. Appropriateness of the experiments that are done

Specification

- Experiments must address the following questions:

  Is Sumacan expressed in the prostate?
  Is Sumacan expressed in prostate cancer?
  Is there a difference between the expression of Sumacan in the prostate and in prostate cancer?

2. Quality of laboratory research

Specifications

- Acceptance for publication of two articles in a top-tier research journal
- Upon submission of a request to NIH for funds to continue the research begun, receipt of a percentile score on first-round submission of at least 25% and subsequent funding on the resubmission

3. Awareness of the research by people in the field

Specifications

- Several requests received for information about the research
- At least two publications about the research in the scientific literature
- At least two conferences at which papers on the research results are presented

Section 3: Constraints

Limitations

- The NIH proposal is due June 1, 2004. This means that the first scientific manuscript must be submitted to a journal by approximately January 1, 2004, and accepted by mid-April 2004.
- Our lab has limited funds to cover the generation of preliminary data, which means that productivity has to be reviewed monthly.

Needs

- Our lab needs to be able to grow prostate cancer cells.
- Our lab needs to be able to handle human prostate cancer specimens.

Section 4: Assumptions

- The current research team will be willing and able to perform prostate cancer studies (in addition to their brain tumor studies).
- The collaborators will be able to work with our group or will provide the name of another person who wants to collaborate.

Question: We usually have open-ended activities. Is it appropriate to go off on tangents not committed to a particular audience?

Answer: Yes, but, as in other situations, you should clarify your focus. What constitutes success for you? What do you need to do to achieve that success? For example, your focus might be to secure future funding or publish papers. From that new focus, identify who belongs in your audience list.

- *Supporters:* People who will perform the work or make the work possible (e.g., the students and postdocs in your lab as well as the program director for the organization that is funding the project).
- *Observers:* People who have an interest in your project but are neither drivers nor supporters—they're interested in what you're doing, but they're not telling you what to do or how to do it (e.g., other scientists working in your field).

Why do you need an audience list? Because a project can succeed only if everyone involved does his or her part. To increase the odds of that happening, it helps to think about who has an interest in your project and what that interest is.

Project Audience: A Real-Life Example

Drivers

- Myself (lab principal investigator)
- Theresa, the postdoc who started this project

Supporters

- Kathy, the potential genetics collaborator
- Rajiv, the potential pathology collaborator
- Mike, the collaborator in my department who will provide the prostate cancer cells
- Bob, a postdoc
- Ming Li, a graduate student
- Steve, a graduate student
- Research journal editors and reviewers
- National meeting organizers and reviewers
- NIH grant review committees
- NIH project managers

Observer

- Vince, my department chair

To avoid misunderstandings down the line, it's a good idea to make sure that all your audiences agree about which group—or groups—they belong in. For example, your department chair may be a driver, a supporter, or an observer, depending on your relationship with him or her. As you work on the project, revise the list as necessary.

Categorizing audiences is less difficult than it may look, and you don't have to start from scratch for every activity. Many of the same people are likely to be on your audience list over time for different activities.

Develop the Work Breakdown Structure

One of the most important benefits of project management is that it helps you more accurately anticipate how much time a project will take and what resources you need. The work breakdown structure, or WBS, is an outline of all the work that will have to be performed in your project. The WBS corresponds to a research plan in a grant proposal. The WBS is relevant for just about any undertaking because every project has distinct steps that must be performed. The WBS is a hierarchy of increasing levels of detail. Start with broad work assignments, break them down into tasks, and divide these tasks into discrete subtasks, if that level of detail is needed (see figure 7.1).

Figure 7.1. Example of a work breakdown structure

This work breakdown structure outlines a project designed to generate preliminary data that will result in a scientific publication and submission of a grant application to NIH.

Determine whether there is a difference in expression of Sumacan between normal prostate tissue and prostate cancer.

Activity/Task 1
Determine whether Sumacan is expressed in the prostate.

Activity/Task 2
Determine whether Sumacan is expressed in prostate cancer cells.

Activity/Task 3
Determine whether there is a difference in Sumacan expression between the normal and cancerous prostate.

Activity/Task 1
Determine whether Sumacan is expressed in the prostate.

1. Determine where human prostate cells can be obtained.
2. Determine how to grow human prostate cells.
   a. Determine the type of medium and serum they require.
   b. Determine the optimal conditions for growth.
3. Determine whether we can isolate RNA and protein from human prostate cells.
   a. Use the same technique we use to isolate RNA from brain cells or develop a different technique.
4. Determine whether we can perform quantitative RT-PCR for Sumacan expression.
   a. Determine what primers and positive and negative controls we should use.
5. Determine whether we can perform a Western blot for Sumacan expression.
   a. Determine whether the antibody we use in the brain works in the prostate and what size protein band(s) is identified.
   b. Determine which positive or negative controls we need to use for protein quality and Sumacan identification.

Note: Steps 1 to 3 must be done sequentially, but once step 3 is completed, steps 4 and 5 can be done at the same time.

Activity/Task 2
Determine whether Sumacan is expressed in prostate cancer cells.

1. Determine where human prostate cancer cells can be obtained.
2. Determine how to grow human prostate cancer cells.
   a. Determine the type of medium and serum they require.
   b. Determine the optimal conditions for growth.
3. Determine whether we can isolate RNA and protein from human prostate cancer cells.
   a. Use the same technique we use to isolate RNA from brain cells or develop a different technique.
4. Determine whether we can perform quantitative RT-PCR for Sumacan expression.
   a. Determine what primers and positive and negative controls we should use.
5. Determine whether we can perform a Western blot for Sumacan expression.
   a. Determine whether the antibody we use in the brain works in prostate cancer cells and what size protein band(s) is identified.
   b. Determine which positive or negative controls we need to use for protein quality and Sumacan identification.

Note: Steps 1 to 3 must be done sequentially, but once step 3 is completed, steps 4 and 5 can be done at the same time. In addition, tasks 1 and 2 can be done at the same time, although this may result in a higher rate of failure and higher resource costs.

Activity/Task 3
Determine whether there is a difference in Sumacan expression between the normal and cancerous prostate.

1. Determine the difference in RNA expression.
2. Determine the difference in protein expression.
3. Determine the relationship between RNA and protein expression.

Note: Task 3 involves analysis of the data collected in tasks 1 and 2 and thus cannot be performed until these two tasks are completed.

What level of detail is necessary? To decide whether a particular part of the project is detailed enough, ask yourself three questions:

- Can you come up with a reasonable estimate of the resources required for this work?
- Can you come up with a reasonable estimate of the time required to do this work?
- Would anyone to whom this task is delegated understand it well enough to do it to your satisfaction?

> **Question:** Is project management a top-down or a mutual process?
>
> **Answer:** It must be mutual. For the best possible outcome, you need both staff insights and "buy-in." Project management does not say, "Forget thinking and just do what I say." It's a process for identifying *what* to think about, not *how* to think about it.

If the answer to any of these questions is "no," more detail is necessary.

One function of a WBS is to help your supporters carry out the work. The level of detail you need depends, in part, on who those supporters are. Most undergraduates will need more detail than an experienced postdoc or technician.

When you develop a WBS, think in one- to two-week increments. You probably wouldn't want to include detailed plans for activities that take less time (e.g., experiments to be done each day). But keep in mind that this, like most specific project management guidelines, is merely a rule of thumb.

In science, it's unlikely that you'll be able to make a detailed plan very far in advance. Much of the detailed planning will be done "on the fly" as the project proceeds. Try a rolling approach, in which you revise estimates in more detail as you progress through the project. But even if you don't end up following your detailed plan, making such a plan can be beneficial.

Electronic Tools of the Trade: Project Management Software

Project management software is handy, especially for large and long-term projects. For example, it can help you spot resource conflicts (such as one person assigned to three overlapping activities) and identify which activities can be delayed to accommodate that problem without jeopardizing the schedule. Good software helps you brainstorm the organization of activities on screen, create a WBS, link activities, develop a schedule, identify resources, maintain information on progress, and generate reports. When you make a change, the software reflects the impact of that change throughout the project.

Like other software, project management programs come with bells and whistles you may never need or use. Remember that software is merely a tool to help you plan and organize your work. It should not *become* your work, bogging you down in complex manipulations or fancy graphs and charts that look impressive but don't improve on simpler presentations of the information. A good rule for all software is "Use what you need and ignore the rest."

Microsoft Project is one of numerous such software programs. For information about others, see *http://www.project-management-software.org*.

The WBS will support the planning, organizing, and tracking functions in the next steps. Specifically, it will help you schedule the project and its parts, estimate resources, assign tasks and responsibilities, and control the project. (For more information about this tool, see *http://www.4pm.com/articles/work_breakdown_structure.htm*, cited in Portny and Austin, "Project Management for Scientists.")

Using the WBS to delegate tasks. The resources of a lab as a whole are delegated differently for different projects, but a WBS can help in setting up the lab and dividing big tasks into smaller ones—for example, ordering equipment, hiring staff, and dealing with compliance issues. Encourage your staff to develop a WBS for each of their projects.

Question: If I have experiments A, B, C, and D, is it reasonable to do detailed planning only for A first and deal with the others later?

Answer: That may be reasonable, but what if B isn't entirely dependent on A, and you could have done some work for B or any of the others without waiting until A was done? Project management tools and software can help you see where timelines may overlap, so that you can use your time most productively.

Schedule the Project

Project schedules should include realistic estimates of how long it will take to perform each activity and the order in which the activities are to be performed. The tool for this step is a network diagram, a flow chart of the proposed work showing the sequence and time associated with each task. Network diagrams include the following three elements:

- *Event:* A milestone that signals the start or end of an activity (e.g., a paper based on preliminary data for a project is submitted).
- *Activity:* The work needed to advance from one event to the next, described with action verbs (e.g., prepare reagent, do meta-analysis of preliminary data).
- *Duration:* The time necessary to finish an activity. Many factors influence how long an activity takes, such as staff commitments and equipment capacity.

When you have this information, you can develop feasible schedules. Several formats can be used to organize a schedule:

- *Key events schedule:* A table showing events and target dates for reaching them (see figure 7.2, page 112).
- *Activities plan:* A table showing activities and their planned start and end dates (see figure 7.3, page 113).
- *Gantt chart:* A graph in timeline format showing planned start, performance, and end dates for activities.
- *Combined milestone and Gantt chart:* A graph in timeline format showing start, performance, and end dates for planned activities and when certain events will be reached (see figure 7.4, page 114).

Key Steps in Scheduling Activities and the Tools Needed

1. Identify activities (work breakdown structure).
2. Identify constraints (statement of work).
3. Determine durations (network diagram).
4. Decide on order of performance (network diagram).
5. Develop initial schedule (key events schedule, activities plan, Gantt chart, or combined milestone and Gantt chart).
6. Revise schedule as necessary.

Figure 7.2. Example of a key events schedule*

Key Event (Task)	Description	Person Responsible	Date Due	Comments
1 (1)	Prostate cells found	Theresa	August 5	
2 (1)	Prostate cancer cells found	Bob	August 5	
1 (2)	Prostate cells successfully grown	Theresa	August 26	
2 (2)	Prostate cancer cells successfully grown	Bob	August 26	
1 (3)	RNA and protein isolated from prostate cells	Theresa	September 26	
2 (3)	RNA and protein isolated from prostate cancer cells	Bob	September 26	
1 (4)	RT-PCR of Sumacan from prostate cells completed	Theresa	October 26	
2 (4)	RT-PCR of Sumacan from prostate cancer cells completed	Theresa	October 26	
1 (5)	Western blots to demonstrate Sumacan in prostate cells completed	Bob	October 26	
2 (5)	Western blots to demonstrate Sumacan in prostate cancer cells completed	Bob	October 26	
3 (1)	Comparison of Sumacan RNA levels in prostate and prostate cancer cells completed	Theresa and Bob	November 5	
3 (2)	Comparison of Sumacan protein levels in prostate and prostate cancer cells completed	Theresa and Bob	November 5	
3 (3)	Relationship between RNA and protein levels of Sumacan determined	Theresa and Bob	November 5	

*This figure is based on work breakdown structure outlined in figure 7.1.

Figure 7.3. Example of an activities plan*

Activity (Task)	Description	Person Responsible	Start Date	End Date	Comments
1 (1)	Look for sources of prostate cells	Theresa	August 1	August 5	
2 (1)	Look for sources of prostate cancer cells	Bob	August 1	August 5	
1 (2)	Try to grow prostate cells	Theresa	August 5	August 26	
2 (2)	Try to grow prostate cancer cells	Bob	August 5	August 26	
1 (3)	Try to isolate RNA and protein from prostate cells	Theresa	August 26	September 26	
2 (3)	Try to isolate RNA and protein from prostate cancer cells	Bob	August 26	September 26	
1 (4)	Try to perform RT-PCR from prostate cells	Theresa	September 26	October 26	
2 (4)	Try to perform RT-PCR from prostate cancer cells	Theresa	September 26	October 26	
1 (5)	Try to perform Western blots on prostate cells	Bob	September 26	October 26	
2 (5)	Try to perform Western blots on prostate cancer cells	Bob	September 26	October 26	
3 (1)	Compare the levels of Sumacan RNA in the prostate and prostate cancer cells	Theresa and Bob	October 26	November 5	
3 (2)	Compare the levels of Sumacan protein in the prostate and prostate cancer cells	Theresa and Bob	October 26	November 5	
3 (3)	Compare the levels of Sumacan RNA and protein to each other	Theresa and Bob	October 26	November 5	

*This figure is based on work breakdown structure outlined in figure 7.1.

Note: Each of these activities can be broken down further if more detail is needed. For example, if the activities are being performed by a new graduate student, you may want to explain the different protocols to use to perform RT-PCR from prostate cancer cells and what controls should be used as well as alternative protocols to use in case the first ones do not work.

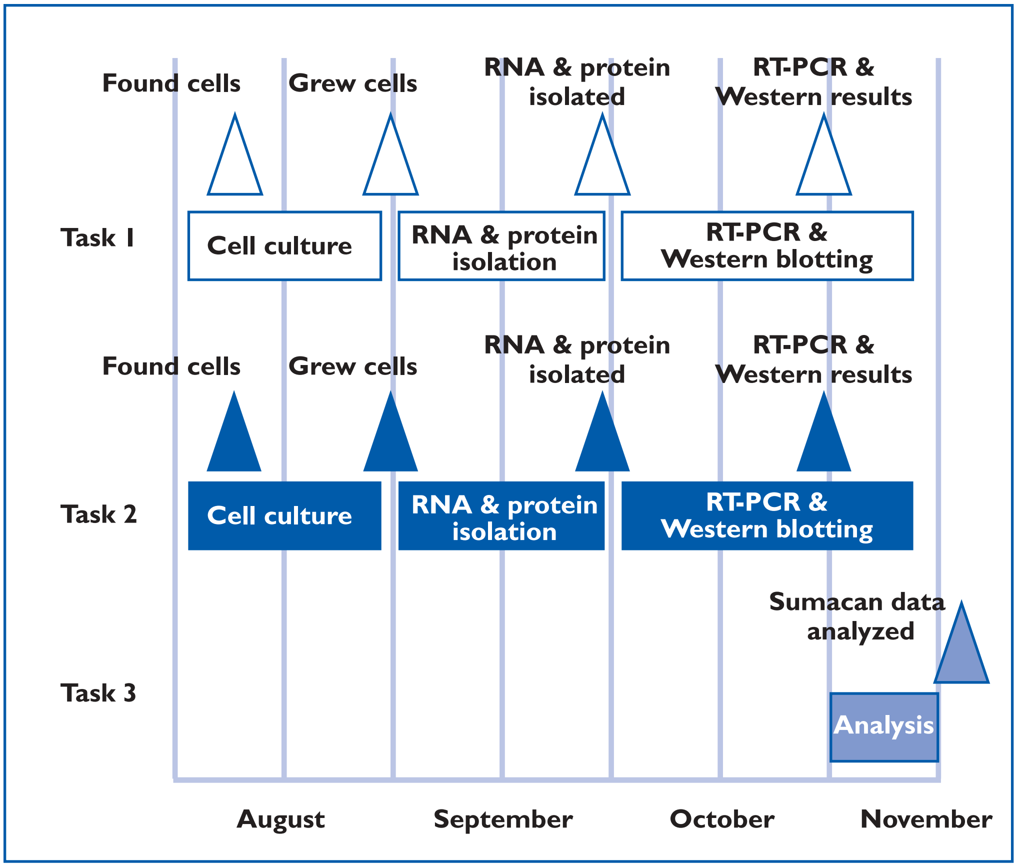


Figure 7.4. Example of a combined milestone and Gantt chart

The key events schedule and the activities plan (figures 7.2 and 7.3) display dates better; the Gantt chart and the combined milestone and Gantt chart (figure 7.4) give a better overview of how long activities take and where they coincide. Regardless of which format you use, take the time to develop a schedule you have a reasonable chance of meeting.

Estimate Resources: The Resource Matrix and Loading Chart

Before you begin any project—even one as seemingly clear-cut as preparing a presentation—you should have a thorough list of the resources required. The resource list will be specific to each project—the work you've described in the WBS and the time frames you have developed with the network diagram.

Resources include people, funds, equipment, raw materials, facilities, and information. The following tools are helpful for displaying resource requirements:

- *Resource matrix:* Shows how much of a given resource you'll need for each activity in the WBS (see figure 7.5).
- *Loading chart:* Shows how much of a resource you'll need at different times during an activity (see figure 7.6, page 116).

Figure 7.5. Example of a resource matrix (person-hours)

Following the WBS in figures 7.1 to 7.3, Theresa is provided with an undergraduate student (Max) and Bob is provided with two high school students (Yvonne and Lauren) to help with this project. The final analysis will need dedicated time from the principal investigator.

Key Event (Task)	Activity	Theresa	Max	Bob	Yvonne	Lauren	Principal Investigator
1 (1)	Look for sources of prostate cells	3	8				
2 (1)	Look for sources of prostate cancer cells			8	8	8	
1 (2)	Try to grow prostate cells	20	40				
2 (2)	Try to grow prostate cancer cells			20	30	30	
1 (3)	Try to isolate RNA and protein from prostate cells	24	44				
2 (3)	Try to isolate RNA and protein from prostate cancer cells			24	50	50	
1 (4)	Try to perform RT-PCR from prostate cells	100	120				
2 (4)	Try to perform RT-PCR from prostate cancer cells	100	120				
1 (5)	Try to perform Western blots on prostate cells			100	120	120	
2 (5)	Try to perform Western blots on prostate cancer cells			100	120	120	
3 (1)	Compare the levels of Sumacan RNA in the prostate and prostate cancer cells	40		40			10
3 (2)	Compare the levels of Sumacan protein levels in the prostate and prostate cancer cells	40		40			10
3 (3)	Compare the levels of Sumacan RNA and protein to each other	40		40			10

Figure 7.6. Example of a loading chart

This loading chart displays Theresa's workload. She is responsible for the first three steps in Task 1. In addition, during the time the project is being run, she will be teaching a microbiology lab course (5 hours/day with monthly exams).

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Task 1 Step (Hours)	1 (3)	2 (10)	2 (5)	2 (5)	3 (5)	3 (5)	3 (5)	3 (9)
Microbiology Lab Hours	25	25	25	35	25	25	25	35
Total Time	28	35	30	40	30	30	30	44

Note: There might be a potential problem in week 8, when Theresa's workload exceeds 40 hours per week.

A resource matrix demonstrates the amount of work needed to complete a task, no matter how many people are involved. A loading chart shows the amount of work a particular individual will devote in each time period, so that people who have too much work (and thus could be potential bottlenecks to the flow of the project) can be identified.

Question: I've done some experiments so many times that I don't need to plan the work or resources. Do I still need to?

Answer: Not for your benefit, but you have to consider whether others need to know what you're doing—the sequence of steps as well as the materials and time required. If they do, project management tools are a useful part of the record. Project management isn't just a planning tool, it's also a training and communication tool.

Be sure to take into account everyone who is needed to complete each task listed on the WBS. For example, if you need specialized expertise outside your lab for data analysis, make sure that you have identified a suitable person, that the person has given you an estimate of work time he or she will require, and that your project schedule accommodates the expert's availability (as well as any time that might be needed for delivery of the data and return of the analyses).

If your work or any part of it has been done before by others, you may have some guidance in estimating resources. Consult written records of relevant work or speak with those who were involved. However, before you rely on the experience of others, make sure the equipment, schedule, and personnel qualifications were sufficiently similar to what you propose. In addition, be conservative in your estimates. Nothing is more frustrating than being unable to continue a project that is going well because you don't have enough resources.

ORGANIZING THE PROJECT

Assign Tasks and Responsibilities: The Linear Responsibility Chart

> *The greatest chances for success are achieved when project information is used to align, guide, and motivate team members, and when these team members, in turn, use this information to guide their work.*
>
> —Stan Portny and Jim Austin, "Project Management for Scientists," *Science*'s Next Wave, 2002

The statement of work encourages you to spell out your assumptions explicitly. The WBS pushes you to think comprehensively about tasks and subtasks. A linear responsibility chart lets you assign a person to each of the tasks you have identified. (For the example used throughout this chapter, Theresa is directly responsible for the prostate cell lines, RNA and protein isolation, and the RT-PCR from both the prostate cells and prostate cancer cells. Bob is responsible for the prostate cancer cells, RNA and protein isolation, and the protein Western blots on the prostate and prostate cancer cells.) Keep in mind that responsibilities extend beyond performing core project tasks; for example, communicating with audiences is an activity associated with the operation of a lab and its projects. The more such tasks you can identify and assign, the more smoothly work will proceed. (For the example used throughout this chapter, the principal investigator will communicate with the department chair, NIH, journal editors, and the external collaborators; Theresa will communicate with the undergraduate student Max; and Bob will communicate with the high school students Yvonne and Lauren.)

Finally, an accurate assessment of the skills, experience, and limitations of your staff will help you match the right people to each task. Stretching is good, but overreaching is not. If your team lacks the expertise required for a critical activity, you may have to reconsider your approach or seek out a collaborator.

Question: Despite the best explanations, inexperienced students may focus only on their part of the work. Are there devices to help them get the big picture?

Answer: It's important that they do get the big picture, and project management may be part of the solution. Although it's true that project management encourages a focus on details, it also encourages you to consider the big picture. Students, especially smart ones, may be reluctant to admit what they don't know. You can convey to them that it's all right to ask. Get them to talk, and paraphrase what they say. If that doesn't work, ask them to write a statement of work for their part of the project, which requires background on the entire project.

CONTROLLING THE PROJECT

Effective project management demands that the components of a project be constantly monitored and revised as new information arises. In science, it is hard to predict how the course of a project will run. Flexible planning is needed to help you deal with the unexpected and to keep the project under control. The following is a list to help you stay on track:

- Anticipate and address the potential for shifts from the original plan.
- Consider different scenarios to identify what may not unfold as you anticipate, and identify the range of ramifications.
- Select aspects of your project that are most likely to produce deviations (e.g., a graduate student who is not familiar with interpreting experimental results and thus may slow progress or a technician who does not aggressively follow up on orders from a slow vendor and thus may not receive needed reagents on time), and monitor them closely.
- Develop strategies to reduce the likelihood of deviations, as well as contingency plans for any that occur.
- Create indicators or defined results (such as a completed Western blot or a clearly interpretable experimental finding) that will help you evaluate the project against your stated objectives. The indicators should be clear and directly relate to your objectives. Poorly chosen indicators are worse than none at all and may cause you to abandon a project when in fact the objective may be sound.
- Monitor the project carefully and consistently to promptly identify detours from course.
- Implement contingency plans, and revise your master plan as necessary.

This process may sound complex, but it's essential, and once you're used to it, it is easy to implement for most projects in an academic laboratory. As a scientist, you want your research to be worthwhile, even if it doesn't proceed the way you planned

Keeping People Motivated

Especially for long-term projects, it's important to encourage the project team to be enthusiastic and to motivate them to reach key milestones. Paying attention to the following four points can help you do that.

Desirability: To stay focused and committed, people need to have a sense of value in what they're doing. "What's in it for me?" is a valid question. Emphasize the benefit to each individual of his or her work, as well as the value to the lab and the organization.

Feasibility: People have to believe that what they're attempting can be done. In fact, a major purpose of laying out plans in advance is to determine and demonstrate that the project is feasible.

Progress: People need to see progress in both the small and large pictures throughout the project. The one- to two-week increment in project planning gives you an opportunity for periodic motivational feedback.

Reward: This is a concept that extends beyond promotions and salary increases. It's a matter of showing members of your team the value of their contributions.

Question: How do I finish projects while allowing key people to leave when they're ready?

Answer: Project management can help you anticipate and plan for their departure. Identify who's most likely to leave and the places in the project where that's most likely to happen. When it does happen, stop and assess the impact on your project and determine steps you can take to minimize the effects. You can also ask staff to stay for a while, until the project reaches a stage where their departure will be less disruptive.

or produce the expected outcome. Much useful information can be salvaged from completed (or abandoned) projects that might be considered unsuccessful when measured against the statement of work. To get the most out of your investment of project resources, learn to work through the "what ifs" by positing multiple possible outcomes and timelines and planning ways to deal with each one.

A project plan should be more than a suggestion but less than a straitjacket. It's important to recognize that the outcomes, end dates, and budgets specified in your plan are always provisional.

RESOURCES

Austin, Jim. "Management in the Lab." *Science*'s Next Wave (September 13, 2003), http://nextwave.sciencemag.org/cgi/content/full/2002/09/10/7.

Austin, Rob. "Project Management and Discovery." *Science*'s Next Wave (September 13, 2003), http://nextwave.sciencemag.org/cgi/content/full/2002/09/10/4.

Harmening, Denise M. *Laboratory Management: Principles and Processes.* Upper Saddle River, NJ: Prentice Hall, 2003.

Portny, Stanley E. *Project Management for Dummies.* New York: Hungry Minds, 2001.

Portny, Stanley E., and Jim Austin. "Project Management for Scientists." *Science*'s Next Wave (July 12, 2002), http://nextwave.sciencemag.org/cgi/content/full/2002/07/10/7.

Portny, Stanley E. "Project Management in an Uncertain Environment." *Science*'s Next Wave (August 23, 2002), http://nextwave.sciencemag.org/cgi/content/full/2002/08/21/3.

budget
publications

Chapter 8

DATA MANAGEMENT AND LABORATORY NOTEBOOKS

This chapter is based on the session "Data Management and Laboratory Notebooks" that was held at the BWF-HHMI Course in Scientific Management. The session was organized by Maryrose E. Franko, Ph.D., Howard Hughes Medical Institute, with presentations by David J. Adams, Ph.D., Duke University Medical Center; Howard Kanare, Construction Technology Laboratories; and Joseph M. Vinetz, M.D., University of Texas Medical Branch–Galveston. Additional information was obtained from some of the resources noted in this chapter.

As science explodes with new information and competition increases, and as academic scientists engage in more collaborations with industry scientists, proper recording of laboratory activities and managing the volumes of data produced by a laboratory are becoming increasingly important.

This chapter covers some of the basics: the importance of day-to-day record keeping and good practice for laboratory notebooks; what to consider when developing a system to track and store information; and finding the right data management system for you.

DAY-TO-DAY RECORD KEEPING: THE LAB NOTEBOOK

Why Keep Daily Records?

Every person working in a lab should keep detailed records of the experiments conducted each day. Here are some reasons why.

Establishing good work practices. Lab records allow your work to be reproduced by others. The records you keep should allow you and others to re-create the work and achieve the same results, thereby validating or extending your work. The records also allow you to prepare formal reports, papers, and presentations. They also serve as a source for assigning credit to lab members.

Teaching the people in your lab. Scientific training involves gathering information, forming hypotheses, designing experiments, and observing results. Lab notebooks, in which these activities are carefully recorded, can be a valuable aid in teaching your grad students, postdocs, and technicians how to analyze results, construct new theories and tests, and retrace their steps to identify an error.

> *Enter all your work in a notebook—even procedures that did not work.*
>
> —David Adams, Duke University Medical Center
>
> *Reading notebooks is a nonconfrontational way to keep current with your students' and postdocs' work, and notebooks are critical when these lab members leave.*
>
> —Joseph Vinetz, University of Texas Medical Branch–Galveston

Meeting contractual requirements. From grants to contracts to patent applications, researchers have explicit terms and implicit expectations to meet, for which detailed records and data are essential. For example, the National Institutes of Health has the legal right to audit and examine records that are relevant to any research grant award. Accordingly, the recipients of research grants have an obligation to keep appropriate records.

Question: For patent purposes, what's an "original" record?

Answer: An original is the first human-readable form—for example, a printout of a measurement but not a photocopy of it. It should be dated, signed, and filed.

Question: Genomics produces massive amounts of data. If the data are burned on a CD, are they considered "original"?

Answer: In this era of computer-assisted research, many pieces of data are collected, stored, and analyzed by computer. The problem with electronic records is that it is hard to prove that the data are not added to, deleted from, or in some way tampered with. The Food and Drug Administration (FDA) has published clear guidelines for maintaining electronic records in a way that will meet legal scrutiny (*http://www.fda.gov/ora/compliance_ref/part11/*). If you have really important results, it is probably safer to print them out, sign and date the documents, and indicate why they are significant.

Avoiding fraud. Lab directors are responsible for the integrity of their lab and everything it produces. Periodic checks of raw data in notebooks and project files can uncover and correct carelessness or outright fraud before it becomes a huge problem.

Defending patents. U.S. patent law follows a first-to-conceive rather than a first-to-file system. That is why documentation to support the date of discovery or invention is critical and why pages of lab notebooks and other records should be consecutively numbered, dated, and signed. Careful records can save a patent.

Good Practice for Laboratory Notebooks

Although individual scientists are responsible for maintaining their own notebooks, heads of labs are responsible for making sure that the notebooks of those under their direction are in order. The precise way in which to document scientific research varies from field to field and from institution to institution, but some general rules apply, such as the following:

- Use a permanently bound book, with consecutive signed and dated entries. When appropriate, witness entries as well.

Question: Why should I learn to write in the notebook?

Answer: You want to create an accurate, original, permanent record. There is a tendency to record information on the handiest piece of paper available, even on a paper towel lying on a bench, and then later transferring the information to a notebook. Therefore, you should get into the habit of immediately recording data as they are being collected into your lab notebook.

Question: What's the responsible way to document errors?

Answer: Make the required changes as soon as possible without obliterating the original entry. Electronic documents may require a new entry, not an override. If the error is logged by hand, do not erase or alter the initial entry. Correct the data at the point in the log where the error was discovered, refer to the original page, and go on (e.g., "Reagent was 50 percent of the strength we originally thought.").

Question: How do I get people in my lab to keep good records?

Answer: All students, technicians, and postdocs should be issued their own laboratory notebooks, with instructions on how to record in them. Establish expectations early and reinforce them periodically. The job interview is not too early to describe expected lab record-keeping methods and media. Many lab heads have a system for regularly reviewing all lab notebooks.

- For computer-kept logs, you can use a loose-leaf notebook, but pages must be consecutively numbered (using a sequential page-number stamp), dated, and signed.
- Record entries chronologically.
- Each entry should stand on its own to permit others to replicate the work.
- Organize material with sections and headings.
- Identify and describe reagents and specimens used.
- Identify sources of those materials (e.g., reagent manufacturer, lot number, purity, expiration date).
- Enter instrument serial numbers and calibration dates.
- Use proper nouns for items.
- Write all entries in the first person, and be specific about who did the work.
- Explain nonstandard abbreviations.
- Use ink and never obliterate original writing; never remove pages or portions of a page.
- If a page is left blank or a space within a page is left blank, draw a line through it.
- Permanently affix with glue any attachments (such as graphs or computer printouts) to the pages of the notebook; date and sign both the notebook page and the attachment.
- Outline new experiments, including their objectives and rationale.
- Include periodic factual, not speculative, summaries of status and findings.
- Enter ideas and observations into your notebook immediately. Summarize discussions from lab meetings and ideas or suggestions made by others, citing the persons by name.

Electronic Laboratory Notebooks

Electronic laboratory notebooks (ELNs) do everything their handwritten forebears do but with the attractive bonus of search and organization functions. Through links to analytical software, ELNs can usually download and store data directly, and many ELNs also support secure access for multiple users and remote users.

Choosing the right ELN for your lab requires homework. One important consideration is whether the ELN complies with the FDA's rules for acceptance of electronic documents, which were published in March 1997 in title 21 of the *Code of Federal Regulations*, part 11, available online at *http://www.fda.gov/ora/compliance_ref/part11/*.

So far, few ELNs have been subjected to legal scrutiny, and it is doubtful that many would pass the test. For this reason, most researchers in academic and industry settings are sticking to paper records.

When Is a Witness Warranted?

Some companies require that all notebook pages be witnessed. In academia, few labs follow this practice, but under some circumstances, having a certain record signed by a witness is desirable.

Learn to recognize an entry that merits a witness. When you think you have conceived an invention or an idea that may have intellectual property value, the date you did so is when you want a witness. For example, if lunch with a colleague leads you to an idea so tantalizing that you simply must go write it down, that's a notebook page you want witnessed. Another important date from a patent law standpoint is when the idea is put into actual practice, called "reduction to practice" (see chapter 11, "Understanding Technology Transfer").

Learn who constitutes an appropriate witness. Although a witness serves a certifying function much like a notary public, unlike a notary, a witness needs a sound grasp of the science. However, the witness should *not* be a co-inventor, who, from a legal perspective, has a vested interest in verifying the claim. Find someone who is not directly involved in your work but who understands and can explain your idea. You may also need different people to witness pages containing different ideas. Do not designate one person as the "official" witness in your lab. Rote signatures unsupported by suitable scientific credentials will not meet the standard for credibility in court.

Where and How Long to Keep the Notebook

Lab notebooks that are "in progress" should be kept in the lab and reviewed periodically. Usually, notebooks are kept on a lab bench, but if you are concerned about the risk of damage or contamination, make it a rule that at the end of each day, all lab notebooks are placed in a fireproof cabinet or other designated space.

Completed lab notebooks should be indexed and kept in a safe central repository, along with corresponding patent applications or patents. Notebooks should be catalogued. Every time someone takes a notebook, it should be checked out and then returned. A person who is leaving the lab for a position elsewhere should not take any original lab notebooks but could be allowed to take copies of the lab notebooks he or she has maintained.

In general, the principal investigator should keep notebooks for at least five years after funding for the study ends. At that point, the notebooks can continue to be stored on site or moved to a storage facility. For anything that has been patented, the general rule is that the corresponding lab notebooks should be kept for the life of the patent plus six years. Your institution may have specific policies for you to follow. If you move to a new institution, you should also check your old institution's policies; some institutions require departing faculty to leave their original lab notebooks.

> *Every gel should be dried down and put in the lab notebook—even negative results.*
>
> —Joseph Vinetz, University of Texas Medical Branch–Galveston

TRACKING AND STORING INFORMATION

Developing a Data Management System

Take the time to think about and produce a plan to track and store data generated by the people in your lab. Some requirements of your system will include the following:

- **Ability to sort and search.** If you want to be able to sort data in your system by a particular criterion, the information has to be entered as a sortable field. Try to identify at the beginning all the ways you might want to retrieve your data later. This is a challenging but productive exercise in thinking ahead.
- **Consistency.** For comparability, you need standards that are followed consistently. If everyone in your lab uses a different document-naming protocol, the departure of one person can create chaos. Decide on a consistent system for the file names of electronic and paper documents as well as the identification of samples and specimens—everything that your lab catalogues and stores. Figures 8.1 and 8.2 (page 126) present examples of alphanumeric coding systems for electronic documents and specimens.
- **Ability to update records.** It is important that you set up a system for logging in reagents and that everyone in the lab uses the system.

Assign Responsibility

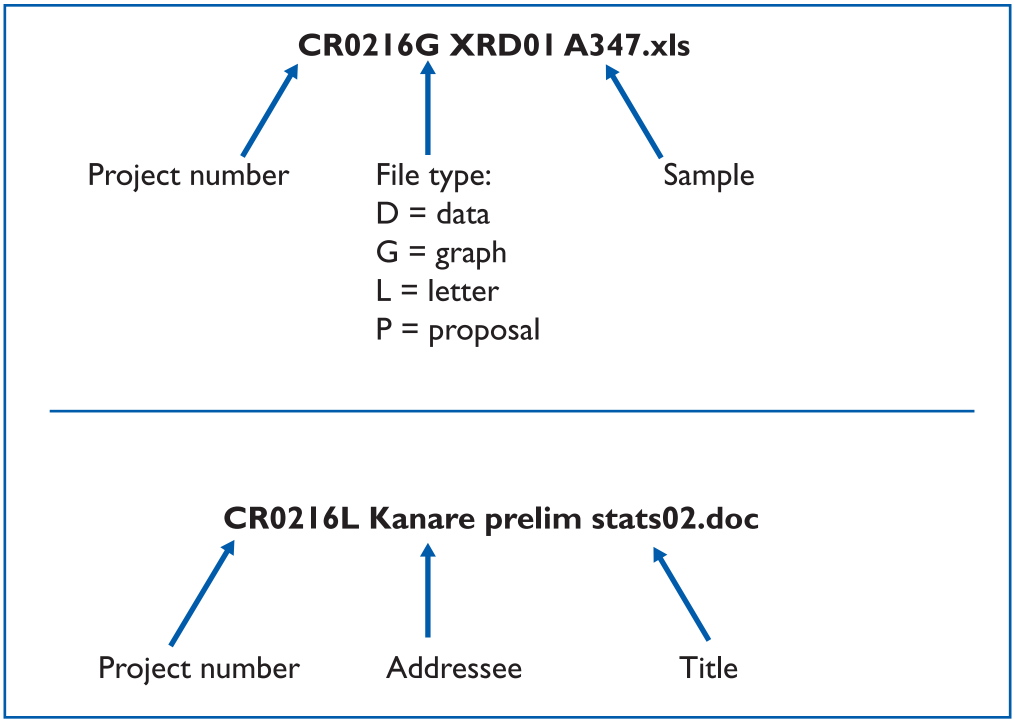
It's not enough to have a data management plan; someone needs to make sure the plan is executed. Because this is your lab, it's your responsibility—to handle personally or to delegate. Once you have made that choice, put quality assurance procedures in place, including scheduled spot checks of your established procedures. Make sure that everyone in your lab knows what to store where, how to do it, and who needs to log in that information.

What to Store and How

You will likely want to store the following:

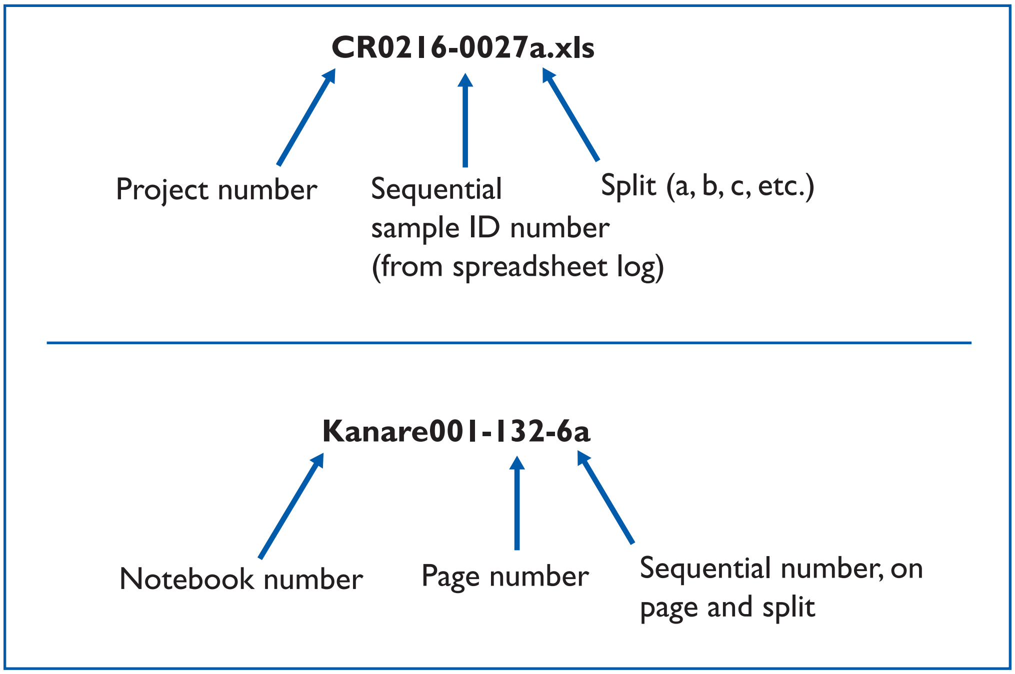
- Lab protocols
- Primary data, including images

Figure 8.1. Electronic document file names



Source: Howard Kanare, Construction Technology Laboratories

Figure 8.2. Sample and specimen IDs



Source: Howard Kanare, Construction Technology Laboratories

- Lists of specimens and reagents
- Information about instruments

Where and how long you keep this information will likely be dictated by the type of information, but you also need to consider issues of lab space, fees and security issues for off-site storage, and the shelf life of the materials being stored. Here are some general guidelines.

Printed records. Records written in ink on acid-free paper and laser-printed records can be archived for a long time; ideal conditions are approximately 50 percent relative humidity and 21°C or cooler.

Electronic records. In theory, CD-ROMs and DVDs can last more than 200 years when stored in the dark at 25°C and 40 percent relative humidity. Floppy disks, however, have a shelf life of only about three years. Similarly, magnetic media are not designed for long-term storage. Another point to consider is whether the hardware and software needed to read the information will be available in the long term.

Lab protocols. Many labs keep a master collection of lab protocols, which is available either electronically or in print and is updated periodically by the revised versions kept in each lab member's own files. Lab protocols are rarely the type of records you need to store for the long term.

Reagents. It is important to have a system in place for keeping track of reagents that are used in your lab. While work is in progress, maintain records about the reagents used and keep the reagents themselves easily accessible in storage. Database programs such as FileMaker are easy to use and useful for keeping track of items such as oligos, antisera, plasmids, and cell lines. Many labs also use Excel spreadsheets or even paper records. When people leave the lab, have them place their unique reagents in storage boxes and document their location. Make sure everyone in the lab updates the database regularly.

You will also need a reliable tracking system for the sharing of reagents—requesting them from other sources and transferring yours to other labs. This involves Request for Materials forms and Material Transfer Agreement forms (see chapter 11, "Understanding Technology Transfer").

Instrument histories. The care and maintenance of equipment are important responsibilities that affect the entire lab. Make sure someone accepts them and follows through. Lab records should include instrument logs that contain purchase, upgrade, and repair information; a calibration schedule and results; a control chart for performance trends; and blind quality control/quality assurance checks.

FINDING THE RIGHT DATA MANAGEMENT SYSTEM FOR YOU

Many academic labs, especially small ones, track samples, reagents, and experiments through paper records and simple electronic spreadsheets. But as the amount and complexity of data grow, some investigators may turn to specialized software products, such as laboratory information management systems (LIMS), data repositories, archival software, and tools to integrate the different applications.

Selecting a suitable program—one that fits your lab's needs and budget—involves something at which you excel: research. Consult colleagues who have been through this process themselves, and don't be shy about involving your institution's information technology office. Once you have narrowed the list of candidate software, arrange vendor demonstrations and visits to labs that use these systems, and, of course, conduct reference checks. Your institution's purchasing office may also be helpful.

> *Redundancy is good. Cross-reference data sources—files, documents, samples—according to whatever consistent alphanumeric or other system your lab uses.*
>
> —Howard Kanare, Construction Technology Laboratories

Some of the questions that you should consider are

- Is the system compatible with your existing software and hardware? Will it interface with your instruments?
- Are other users satisfied? (Talk to people in your field who have purchased a system.)
- What kind of support is available from the vendor?
- How much flexibility does the system offer? Can it be configured to satisfy your particular needs?
- How much training will be required?
- Is the company that sells the system well established or is it likely to be out of business in a few years?
- Is it worth it, or can you get by with the system you already have? Do you really need more software?

Laboratory Information Management Systems

Traditionally, LIMS have been used by chemistry labs that conduct batteries of tests on thousands of samples. In recent years, however, the LIMS marketplace has unveiled new products adaptable to the specialized needs of life sciences research (e.g., microbiology and genomics). LIMS can be used to

- Receive, log in, and label samples
- Assign work (e.g., tests and analyses for each sample)
- Schedule work
- Check status of work

- Integrate data collection by interfacing with instruments
- Track records and specimens

Be aware that a flexible system may not be ready for use straight out of the box. You may have to configure it to your specifications first.

Archival Software

The multitude of data generated by a single lab can be overwhelming. A growing number of software systems allow the user to collect, store, and visualize disparate kinds of information—ranging from mass spectrometry readings to microarray data. The systems provide a central repository for all data generated in a lab. One of the critical features that sets different types of software apart is the degree to which stored data can be retrieved and manipulated in the absence of the original instrument software. Another important consideration is the degree to which the stored data meet the FDA criteria set forth in title 21 of the *Code of Federal Regulations*, part 11 (see box "Electronic Laboratory Notebooks," page 124).

Resource: Buyer's Guide

BioIT World produces an annual buyer's guide of products, including LIMS, which is available at *http://www.bio-itworld.com/buyersguide*.

As principal investigator, you know that maintaining accurate and consistent laboratory records and managing the flow of data your lab generates are critical to the success of your research program. So, be proactive. As you're setting up your lab, determine the standards and procedures for record keeping and communicate these to the members of your lab. Develop a plan to efficiently track and store data and find an electronic data management system to help you implement this plan. Once you've done this, you're well on your way to keeping the avalanche of data organized and retrievable.

RESOURCES

American Association for the Advancement of Science. Scientific integrity videos, *http://www.aaas.org/spp/video/orderform.htm.*

Barker, Kathy. *At the Bench: A Laboratory Navigator*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press, 1998.

Barker, Kathy. *At the Helm: A Laboratory Navigator*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press, 2002.

Bonetta, Laura. "Toward a Paperless Office?" *The Scientist* 17(4):40 (February 24, 2003), *http://www.the-scientist.com/yr2003/feb/lcprofile1_030224.html.*

Brush, Michael. "LIMS Unlimited." *The Scientist* 15(11):22 (May 28, 2001), *http://www.the-scientist.com/yr2001/may/profile_010528.html.*

Food and Drug Administration. Title 21 *Code of Federal Regulations*, part 11 (21 CFR part 11), Electronic Records; Electronic Signatures, *http://www.fda.gov/ora/compliance_ref/part11/.*

Harmening, Denise M. *Laboratory Management: Principles and Processes*. Upper Saddle River, NJ: Prentice Hall, 2003.

Kanare, Howard M. *Writing the Laboratory Notebook*. Washington, DC: American Chemical Society, 1985.

Chapter 9

GETTING FUNDED

This chapter is based on the session "Getting Funded" that was presented at the BWF-HHMI Course in Scientific Management. The session was organized by Jim Austin, Ph.D., American Association for the Advancement of Science, with presentations by Anthony M. Coelho Jr., Ph.D., Office of the Director, National Institutes of Health (NIH); Bettie J. Graham, Ph.D., National Human Genome Research Institute, NIH; and Suzanne Pfeffer, Ph.D., Stanford University School of Medicine. The chapter also includes information provided by Anthony Demsey, Ph.D., Office of the Director, NIH; Michael E. McClure, Ph.D., National Institute of Environmental Health Sciences, NIH; and Carl Rhodes, Ph.D., Howard Hughes Medical Institute. Additional information was obtained from some of the resources noted in this chapter.

You've begun your career as an academic scientist. Your lab is up and running, and your research program is under way. But the pressure is on—soon you will have to find financial support for your research from sources other than your institution. It's time to learn the art of getting funded.

Numerous public and private sources support scientific studies, but the National Institutes of Health (NIH), a component of the Public Health Service under the U.S. Department of Health and Human Services, is by far the nation's largest funder of academic research. For that reason, this chapter focuses on NIH and emphasizes the R01 grant, an investigator-initiated research project grant for which most beginning academic investigators will have to apply.

This chapter provides an overview of the NIH funding process and the two-level review system that is used by NIH for most R01 grant applications. It also details the steps involved in preparing a strong R01 grant application, including turning your concept into a solid research plan and making sure that individuals with the appropriate expertise review your application. In addition, the chapter discusses what to do if your application is not funded.

UNDERSTANDING THE NIH FUNDING PROCESS

NIH Institutes and Centers

An important part of writing a successful grant application is having a good understanding of the mission of the funding organization and the type of projects it supports. At this point in your career, you are probably already familiar with NIH and may have even applied for NIH postdoctoral funding. However, it's still useful to remember that NIH is composed of institutes and centers (I/Cs) whose numbers increase and whose structures are reorganized periodically. (From a grant applicant's perspective, the only relevant distinction between institutes and centers is that an institute can make awards of less than

$50,000 without approval from its national advisory council, but a center cannot.) As of October 2003, NIH had 20 institutes and 7 centers. Each I/C has its own mission and research agenda, and 24 of the current 27 I/Cs have funding programs for extramural awards (research conducted outside their own facilities and staff), including those that fund R01 grants. Although not essential, it will be useful for you to identify an I/C that is likely to be interested in your research (see "Find a Home for Your Application at NIH," page 141).

> *There is no grantsmanship that will turn a bad idea into a good one, but there are many ways to disguise a good one.*
>
> —William Raub, former deputy director, NIH

Question: At what stage in my career should I apply for my first R01 grant?

Answer: After you have accepted a position at a university or medical center, you may be encouraged by your department chair to apply for your first NIH grant, even before you move into your new lab. Some experts warn, however, that it might be better to wait until the second year of your appointment, because it will help your application considerably if you have generated some preliminary data in your new lab. Whenever you decide to apply, remember that you are in that special position of "new NIH investigator" only once; make the most of it.

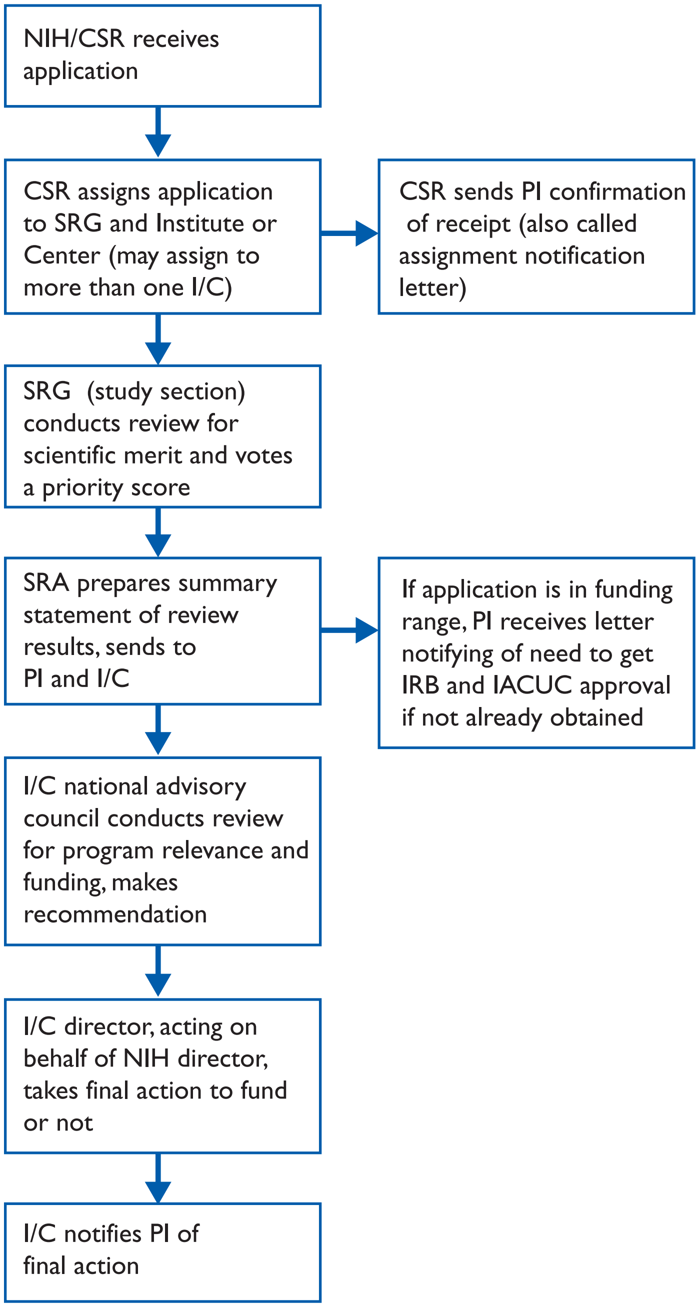
Question: What's the difference between an RFA and a PA?

Answer: An RFA invites grant applications in a well-defined scientific area for which an I/C has determined a specific research need (e.g., to study West Nile virus). This is usually a one-time competition and funds are set aside for a certain number of awards. A PA invites grant applications for a scientific area for which an extramural research program within an I/C has new or expanded interest or continuing interest (e.g., to study drug addiction). These applications are accepted on standard receipt dates on an ongoing basis.

The R01 Review: An Overview

R01 grant applications are usually investigator-initiated. Applications can also be submitted in response to a Request for Applications (RFA) or a Program Announcement (PA), both of which are announced in the NIH Guide for Grants and Contracts (*http://grants.nih.gov/grants/guide/index.html*). R01 applications submitted in response to an RFA are generally reviewed by the issuing I/C. R01 applications submitted in response to a PA are reviewed by the Center for Scientific Review (CSR). Regardless, all applications are sent to the CSR and then follow a two-level review process: 1) CSR assigns the application to a Scientific Review Group (SRG) for evaluation of scientific and technical merit and 2) assigns it to one or more I/Cs to review for programmatic relevance and funding recommendations. (Figure 9.1 provides an overview of this two-level review process.) CSR conducts scientific peer review of approximately 70 percent of the applications sent to NIH; I/Cs evaluate the others. Of the more than 68,000 applications received annually by NIH, perhaps only 25 to 30 percent are funded. The funding range can vary from year to year and from one I/C to another.

Figure 9.1. Overview of the NIH R01 grants process



CSR: Center for Scientific Review
IACUC: Institutional Animal Care and Use Committee
I/C: NIH Institute or Center
IRB: Institutional Review Board
PI: Principal Investigator
SRA: Scientific Review Administrator
SRG: Scientific Review Group

Common Abbreviations

AREA: Academic Research Enhancement Award

CRISP: Computer Retrieval of Information on Scientific Projects

CSR: Center for Scientific Review

IACUC: Institutional Animal Care and Use Committee

I/C: NIH Institute or Center (also written IC)

IRB: Institutional Review Board

IRG: Integrated Review Group

OER: Office of Extramural Research

OHRP: Office for Human Research Protections (formerly OPRR, Office of Protection from Research Risks)

OLAW: Office of Laboratory Animal Welfare (formerly Division of Animal Welfare within OPRR)

PA: Program Announcement

RFA: Request for Applications

RFP: Request for Proposals

SEP: Special Emphasis Panel

SRA: Scientific Review Administrator

SRG: Scientific Review Group

The following is a general guide to the process used to review R01 grant applications.

First-Level Review: Scientific Review Group

One type of SRG, the study section, is used by CSR to review R01 grant applications. Study sections are clustered into Integrated Review Groups (IRGs), organized around a general scientific area. Each study section has a specific scientific focus. (For simplicity, the terms *study section* and *SRG* are used interchangeably in this chapter.)

R01 applications are usually assigned first to an IRG and then to a study section within that IRG. The study section reviews the grant application for scientific merit, rates it with a numerical priority score from which a percentile ranking is derived, and recommends an appropriate level of support and duration of award.

Scores, ranks, and percentiles. Every member of a study section gives each application a rating, or priority score. Those scores are averaged to create a three-digit number, which is that application's final score in the NIH computer system. A 100 is the highest possible score, and a 500 is the lowest possible score. Some applications are not discussed at the review meeting and thus do not receive a score (see "Streamlining and Deferrals," page 136).

Percentiling is a reflection of the rank of a particular score in the pool of all scores given by a study section in its current meeting plus the two previous meetings. For example, an application whose score ranked number 50 out of 100 applications would receive a percentile of 49.5, according to the following formula:

$$\mathbf{P = 100 \times (R - {}^1\!/_2) / N}$$

In the formula, P is the percentile, R is the ranking (in this case, 50), and N is the total number of applications.

The percentiling process is specific to each study section and is the way that NIH I/Cs can account for different scoring behavior in the various study sections. Thus, if the 20th percentile is a 150 priority score in Study Section A and a 190 priority score in Study Section B, both applications are considered in the 20th percentile and treated as such when funding decisions are made by the I/Cs.

Behind Closed Doors: Demystifying the Study Section

Chartered study sections

- Are managed by a scientific review administrator (SRA), a professional at the M.D. or Ph.D. level with a scientific background close to the study section's area of expertise
- Have 12 to 24 members recruited by the SRA, most of whom are from academia—some have long-term appointments and others are temporary members
- Review as many as 60 to 100 applications per meeting
- Usually assign three reviewers to each application
- Are supported by a grants technical assistant, who reports to the SRA

Under the terms of the Federal Advisory Committee Act, study section meetings are closed. Meetings include

- Orientation (discussion of general business)
- Provisional approval of list of streamlined applications
- Discussion of remaining applications

The discussion of applications includes the following:

- Reviewers with a conflict of interest are excused.
- Assigned reviewers present strengths, weaknesses, and their preliminary scores.
- Other members discuss scientific and technical merit.
- Range of scores is expressed (every member scores every application).
- Codes for gender, minority, and children and human subjects are assigned (NIH has requirements for inclusion of women, minorities, and children in clinical research and strict criteria for research involving human subjects and animals).
- Recommended budget changes are discussed.

After each meeting, the SRA documents the results in a summary statement, which is forwarded to both the I/C and the principal investigator.

Summary statements may vary somewhat depending on the SRA, but all of them contain the following:

- Overall résumé and summary of review discussion (for applications that were discussed and scored)
- Essentially unedited critiques by the assigned reviewers
- Priority score and percentile ranking
- Budget recommendations
- Administrative notes (e.g., comments on human subjects or animal welfare)

For more information about what happens in a study section, see the CSR Web site (*http://www.csr.nih.gov*). Also, professional societies, such as the American Society for Cell Biology, often conduct mock study sections at their meetings using already-funded applications.

Poor priority scores. Applications can receive poor priority scores for any number of reasons, including the following:

- Lack of original ideas
- Absence of an acceptable scientific rationale
- Lack of experience in the essential methodology
- Questionable reasoning in experimental approach
- Diffuse, superficial, or unfocused research plan
- Lack of sufficient experimental detail
- Lack of knowledge of published relevant work
- Unrealistically large amount of work for the given time frame or funding level
- Uncertainty about future directions

Question: What should I do if an SRA asks me to be a reviewer for a study section?

Answer: Views differ on this question. Service on a study section can provide valuable insights for grant writing and open professional doors in other ways. However, many senior scientists counsel that junior faculty should wait until they have obtained tenure before accepting an invitation to be appointed to a term on a study section, because they should be devoting their energies to their research, which is the primary basis for the tenure decision. However, agreeing to serve as a temporary member might be appropriate at this stage in your career.

Streamlining and deferrals. A study section gives a score to only about half the applications assigned to it every review cycle. Through a process called "streamlining," applications that are deemed by reviewers to be in the lower half of those assigned for review are read by the assigned reviewers and receive written critiques, but they are not scored or discussed at the review meeting. Any member can object to the streamlining of any application, thereby bringing it to full discussion at the meeting. Streamlining was instituted to allow more time for discussion of applications near the fundable range and to shorten the meetings. This more efficient process also helps attract more reviewers.

A study section can also defer an application if, for example, more information is needed before the reviewers can adequately consider the application. Deferred applications require a majority vote by the study section and are rated "DF." Deferrals are rare.

Second-Level Review: I/C National Advisory Council or Board

After an R01 application has undergone study section review, it undergoes a second-level review by the national advisory council or board of an I/C. The advisory council is composed of people outside the I/C. Approximately two-thirds are scientific members who are generally established in their fields, such as deans or department chairs. Others are advocates for specific health issues and patient populations, ethicists, and laypersons. The secretary of Health and Human Services has ultimate authority to make these appointments.

The advisory council assesses the quality of the study section's scientific review, makes recommendations to I/C staff on funding, and evaluates the application's relevance to program priorities. For every scored application, the advisory council will do one of the following:

- Concur with the study section's action
- Modify the study section's action (but it cannot change the priority score)
- Defer the study section's action for another review, with no changes allowed (e.g., if the principal investigator has appealed, the council may recommend a re-review because it considers the first review flawed)

The I/C director, acting on behalf of the NIH director, takes final action. Awards are made on the basis of scientific merit, program considerations, and available funds. The director usually (but not always) follows the advisory council's recommendations.

Roughly half of the funding I/Cs post their funding plans on their Web sites. The funding plan is the percentile to which the I/C anticipates being able to fund applications on the basis of its budget, recent funding history, and program priorities. If that information is posted, you can check the Web site after you receive the summary statement that shows your application's percentile. Regardless of whether the I/C to which your application was assigned posts its funding plan, you may want to ask your program officer about the likelihood of your obtaining funding.

Review and Funding Cycles

The meetings of the national advisory councils form the basis for NIH's three overlapping review and funding cycles (see figure 9.2). However, NIH is trying to expedite the funding process by making some awards before the council meeting. For example, a candidate for expedited funding might be an R01 application that has a high score, is in an area of strong interest, and does not involve human subjects.

Figure 9.2. Typical timeline for a new R01 application

	Cycle 1	Cycle 2	Cycle 3
Application submitted	February	June	October
SRG (study section) review	June	October	February
Advisory council review	September	January	May
Earliest award	December	April	July

Note: This timeline is specific to R01 research grants. Always check with the I/C to verify due dates for specific types of applications. RFA due dates are stated in the solicitations.

Depending on the I/C, approximately 30 percent of funds are allocated at each of the first two meetings; more is spent at the third meeting. Some I/Cs may be a bit more conservative in funding (e.g., to the 25th percentile) in the first two cycles to hold funds in reserve in case strong applications are submitted during the final funding cycle. In addition, every advisory council and I/C staff have "select pay" for which they can nominate applications that have poorer scores but are of high interest for funding.

As much as possible, consider the timing of your application in terms of the career track at your institution. You want to be funded when decisions about tenure are made.

Other (Non-R01) NIH Opportunities for Beginning Investigators

The following research awards are also available for beginning investigators:

- Mentored Research Scientist Development Award (K01)
- Independent Scientist Award (K02)
- Mentored Clinical Scientist Development Award (K08)
- Small Grant (R03)
- Academic Research Enhancement Award (R15)
- Exploratory/Developmental Grant (R21)
- Career Transition Award (K22)

Many of these programs are announced periodically in the NIH Guide to Grants and Contracts (*http://grants.nih.gov/grants/guide/index.html*). Each has its own criteria for eligibility and submission of applications. Information on these and other NIH extramural funding opportunities can be found at *http://grants1.nih.gov/grants/funding/funding.htm*.

In addition to NIH, other federal agencies and private sector organizations solicit and fund research grants, and each has its own application and review system (see "Resources," page 149). You can send the same application to multiple funding sources in the public and private sectors, but you must disclose your multiple applications to each potential funder to avoid "double dipping" when awards are made.

PREPARING A STRONG GRANT APPLICATION

Getting Started

Successful grant applications begin with a good idea. Figures 9.3 and 9.4 (page 140) show the sequence of steps that can carry you from a good idea through the submission of an application to the final decision about funding.

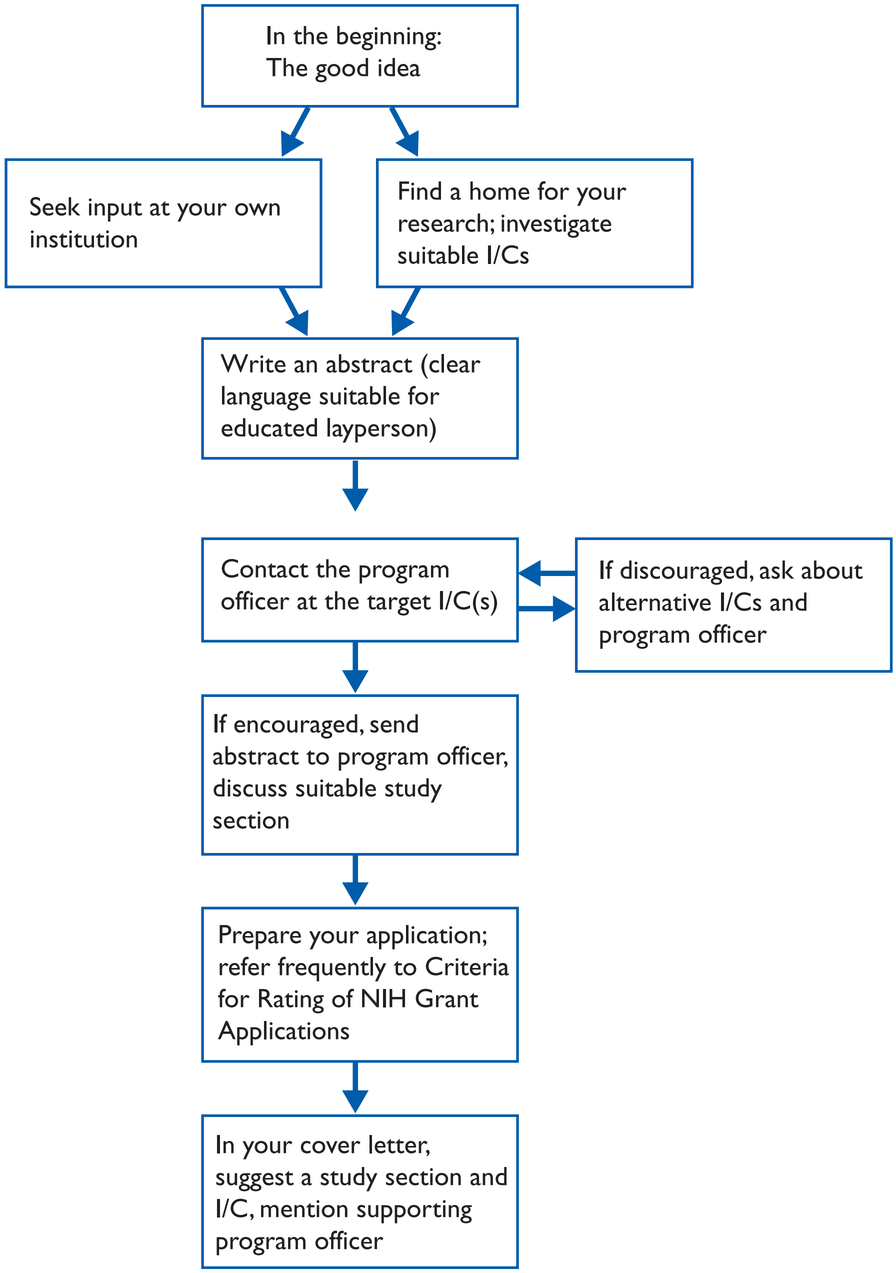
Once you have a good idea, you can get started in two realms: your own institution and an appropriate NIH I/C. These activities overlap to some extent, but they are presented sequentially below.

Seek input at your own institution. An experienced scientific reviewer and NIH grantee recommends seeking peer review of your research proposal at your own institution according to a plan devised by Keith Yamamoto, University of California–San

Calling Beginning Investigators: NIH Wants You

NIH actively seeks to support beginning investigators. When you apply for your first NIH grant, check the box on the form that signals to reviewers that you're a new investigator (meaning you haven't been principal investigator on an NIH research grant before). The reviewers are often more forgiving of applications from novices.

Figure 9.3. The application: From concept to submission



I/Cs: NIH Institutes and Centers

Francisco. The process, which begins at least two months before the application deadline of your grant, involves the following steps:

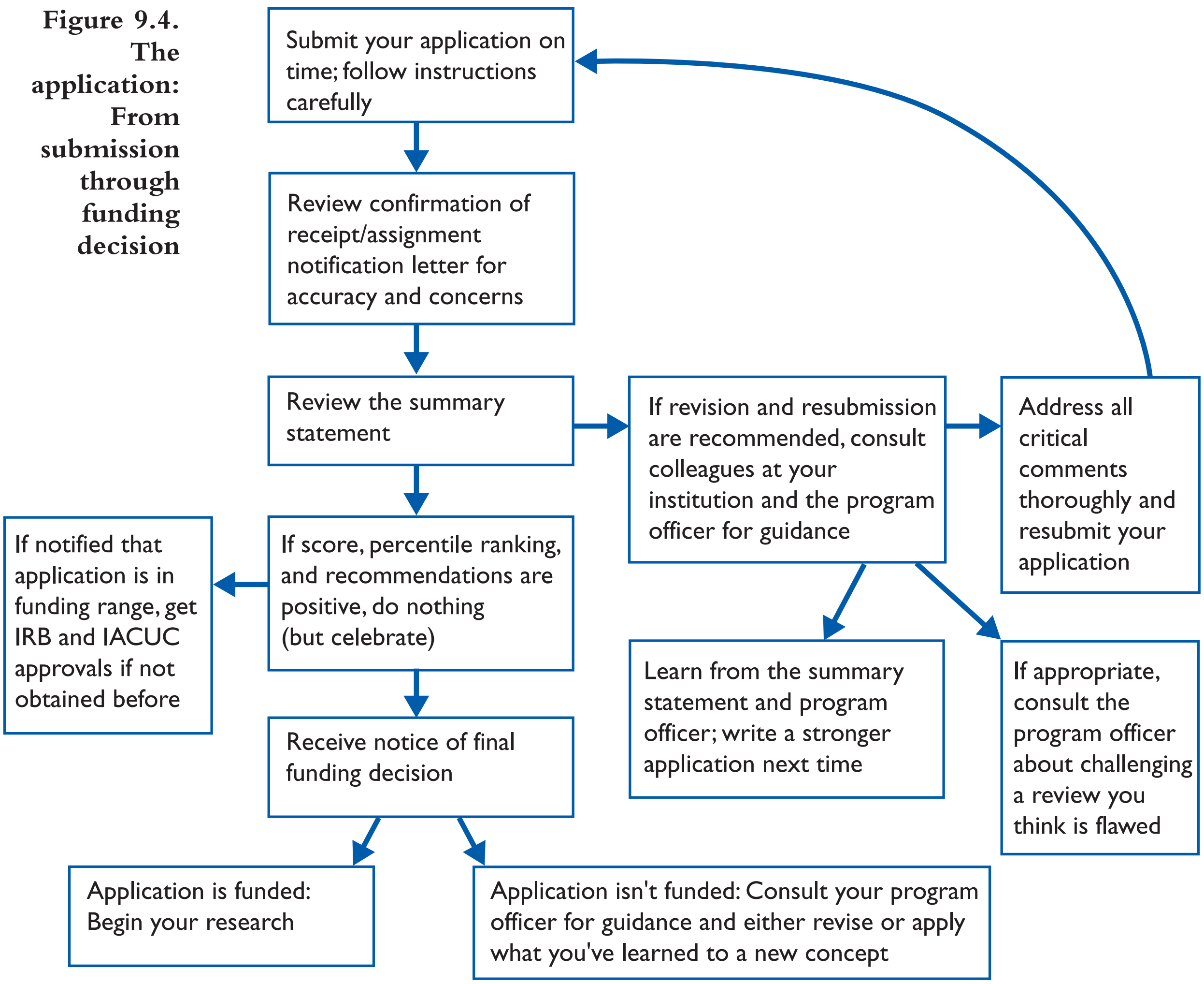
1. Choose three senior colleagues as your "grant committee." Ideally, these would be successful grantees and would include someone who has experience on a study section.
2. Discuss research goals, aims, and ideas with the committee (1.5 hours).
3. Draft one page listing three to five specific aims, and explain why each aim is important.

4. Discuss your aims and rationales with the committee (1.5 hours).
5. Refine your aims according to committee comments.
6. Draft the abstract and the research design and methods sections. Then draft the progress report and the background and significance sections. (See box "Components of the NIH R01 Grant Application," page 141, and "Preparing Your Application," page 143.)
7. Read "Criteria for Rating of NIH Grant Applications" (page 144), and revise your drafts as appropriate.
8. Seek feedback on the drafts from your committee.

In addition to seeking advice from other scientists, seek administrative advice from appropriate review bodies, such as your local Institutional Review Board and Institutional Animal Care and Use Committee.

Reviewers will look for your track record in the field, so if necessary, create one by conducting some preliminary work and presenting the results in your grant application.

Figure 9.4. The application: From submission through funding decision



IACUC: Institutional Animal Care and Use Committee
IRB: Institutional Review Board

Components of the NIH R01 Grant Application

- Research Plan
  - Abstract
  - Specific Aims
  - Background (like a review article) and Significance
  - Progress Report (preliminary results and demonstration of relevant expertise)
  - Research Design and Methods
- Resources and Facilities
- Budget
- Budget Justification

Tip: Conclude each section in the research plan with a few sentences stating what you will learn and why that information is important—for example, "These experiments are important because nothing is known about X, and they will enable us to distinguish between two controversial models that are widely discussed in the field."

For information about how to prepare a grant application form, visit *http://grants.nih.gov/grants/funding/phs398/phs398.html*.

Find a home for your application at NIH. In many cases the appropriate I/C and program officer for your research might be your mentor's. On the other hand, it may take legwork to find the I/C most likely to be interested in your idea. An experienced NIH program officer suggests that beginning scientists should

- Check the NIH Guide to Grants and Contracts (*http://grants.nih.gov/grants/guide/index.html*) for relevant and recent PAs and RFAs.
- Check the NIH CRISP (Computer Retrieval of Information on Scientific Projects) database (*http://crisp.cit.nih.gov*) for projects like yours that have been funded. The two letters in the grant number tell you which I/C funded the project.
- Conduct a literature search to see what has already been done in your area. (This can help you address the innovation aspect of evaluation criteria and, if appropriate, revise your study design or methods accordingly.)

Once you've narrowed the list of potential I/Cs, go to the Web site of each I/C to learn what areas they are currently interested in and are funding. (The NIH Web site lists all its I/Cs and offices at *http://www.nih.gov/icd/*.) I/C Web sites commonly describe scientific areas of interest as well as identify the staff members who are responsible for each program area and maintain a portfolio of grants in that area.

> *Your NIH R01 history is a form of peer review at the national level and is weighed heavily in decisions about promotion and tenure.*
>
> —Suzanne Pfeffer, Stanford University School of Medicine

The I/C program officer is the best person to help you decide what type of grant to apply for and which study section may be most appropriate. The program officer whose area of responsibility is most appropriate to your research also can be your best advocate and adviser at NIH throughout the application process. The program officer will not evaluate the quality of the research idea or the science. That job is left to your institutional colleagues and the study section.

Before you call this key person, be sure to have an abstract of your research project ready (see box "Tips on Writing an Abstract"). The program officer will probably ask for a copy; if not, you can offer to send one.

Tips on Writing an Abstract

The abstract should convey the big picture—the general hypothesis and aims, the methodological approach, and the significance of the research. It should also include key words, which the referral officer at NIH will use to assign your application to the right study section, whether or not you request a particular review group. Try to avoid technical jargon, and write the abstract in language an educated layperson can understand.

Review by more than one I/C. Remember, you can ask for assignment to a second I/C if you've had encouragement from another program officer or think that your application fits within another I/C's scientific areas of interest. Your application can be funded by only one I/C, but more than one advisory council can review it to broaden your chance of funding. In such cases, the application will be assigned a primary and a secondary I/C. The secondary I/C can consider it for funding only if the primary I/C opts to relinquish first right of funding.

Despite your homework on finding the appropriate I/C, the first program officer you contact may not consider your proposal appropriate for funding by that I/C. In such cases, the program officer will likely suggest a more suitable I/C and program officer.

Getting Assigned to the Right Study Section

The most important thing you can do to bolster your chance of funding is to have your application assigned to the right study section. Read the study section descriptions and rosters before finishing and submitting your application. Remember that key words in the title, the abstract, and the specific aims will be used to direct your application to a suitable study section.

If you submit a cover letter, it should contain an informed request for assignment to a specific study section and a brief explanation of why you think it's best suited for your application, as you have determined through your own research and your discussion with the program officer. Include the name of the program officer who supports this request. CSR staff members will consider your suggestion for a study section; if your suggestion is logical, it is likely they will honor it. You can also recommend the type of expertise needed to evaluate your application, but you should not provide specific names of potential reviewers.

After you have been notified about the study section to which your application has been assigned, check the roster to make sure the expertise you consider essential to a fair and thorough evaluation of your application is still represented. If someone who you regard as an important interpreter of your research plan has dropped off the roster, you can request that expertise be added. These requests are generally taken seriously and responded to, and appropriate expertise is provided on site or through an outside review by phone or mail. Similarly, if someone has joined the study section and you think for some reason that this person will not provide a fair review, you can request that this person not review your grant. Be aware, however, that during the study section meeting, the person you are excluding will be informed that you made this request.

Preparing Your Application

First, be sure you're using the most current application form. (The Web site *http://forms.psc.gov/forms/PHS/phs.html* has the most current version of the PHS 398 Grant Application Kit.) Second, follow a simple mantra: Start early, write, read, rest, re-read, revise.

In your application, you should address the following questions, keeping in mind the information given under "Criteria for Rating of NIH Grant Applications," page 144):

- What do you want to do?
- Why is it important?
- Why do you think you can do it?
- Has this area been studied before (and if so, what has been done)?
- What approaches will you use, and why?
- Why do you think it's feasible?
- What will you do if your initial approach doesn't work as planned?
- What resources and expertise are available to you from your institution?

Reviewers Focus on the Four Cs

Clarity. Cross-reference current literature in laying out your premises.

Content. Organize your ideas around associated aims linked to your central hypothesis. (The mission statement of each I/C sets forth its areas of emphasis.)

Coherence of concepts. Present a coherent set of ideas predicated on previous work.

Cutting edge. Be ready to take legitimate risks, preferably based on preliminary data, to move the science forward. NIH rates grant applications on innovation (see "Criteria for Rating of NIH Grant Applications," page 144).

You should keep the following suggestions in mind as you prepare your application:

- Read and follow instructions, paying close attention to budget requirements and eligibility criteria (see "A Bit About Budgets," page 145).
- Prepare your application with care, and use spell check. No matter how strong the science, typos and grammatical errors leave a poor impression.
- Don't try to evade the page limit by using small type or narrow margins. You could delay your application if you disregard NIH's formatting requirements. Don't feel you must write up to the full page limit; you get points for strength, not length.
- Quantify whenever possible.
- Edit. Try to keep your specific aims to two or three sentences each. Remember that reviewers have dozens of applications to evaluate.
- Use language and formatting to create signposts for overworked reviewers, for example:

  The *long-term objectives* of this project are…
  The *general strategy* of the proposed research is to…

The *specific aims* of the present study are to…
Four goals are envisioned: …
In these experiments, molecular genetic, biochemical, and structural approaches will be used to…

- Don't put anything that is critical for reviewers to read, such as key graphics, in an appendix because reviewers are not required to read appendixes.
- Include clear tables, figures, and diagrams (along with legends) in the text.
- Conduct a thorough literature search and cite all relevant literature (omissions here are often a source of criticism). Be sure to discuss your work in the context of these published results.
- Provide preliminary data whenever they exist.

Preliminary data. NIH understands that beginning investigators may not have much opportunity to acquire preliminary data. The NIH Guide to Grants and Contracts (*http://grants.nih.gov/grants/guide/index.html*) often announces programs (e.g., R03 and R21) that are specifically designed to allow new investigators to obtain preliminary data.

Question: How do I distinguish myself from my mentor if I want to continue in the same research area?

Answer: Get a letter from your mentor explaining that he or she is pleased to know that you will be continuing to work on project X, which he or she will not pursue. Have this discussion with your mentor before you start to write the grant application.

Criteria for rating of NIH grant applications. Here are some questions that reviewers will ask about your proposal:

- *Significance:* Does it address an important problem? Will it advance scientific knowledge? Will it affect concepts or methods in this field?
- *Approach:* Are the experimental design and methods appropriate to the aims? Does it acknowledge problem areas and consider alternative tactics (in other words, is there a thoughtful backup plan)?
- *Innovation:* Does it employ novel concepts, approaches, or methods? Does it challenge existing paradigms or develop new methodologies?
- *Investigator:* Is the investigator appropriately trained to carry out the proposed work? Is the work appropriate to the experience of the principal investigator and collaborators?
- *Environment:* Does the institutional environment contribute to the probability of success? Is there evidence of institutional support?

Remember, every yes answer strengthens your application. Every no answer represents an area of potential vulnerability during scientific review. For a detailed description of these criteria, see the PHS 398 application instructions at *http://grants.nih.gov/grants/funding/phs398/phs398.html*. In addition, guidelines for reviewers for grants from new investigators can be found at *http://www.csr.nih.gov/guidelines/newinvestigator.htm*.

A Bit About Budgets

This section does not discuss how to draw up a budget for your grant application. Most institutions have a central grants office with experienced staff who can devise budgets suitable to the scope of the research proposed and in keeping with your institution's policies. Take advantage of that expertise.

However, this section does provide an overview of four budget-related topics. The first, direct costs versus indirect costs, can be the source of misunderstanding between faculty and administration at academic institutions. The next, modular grants, concerns the initial budget request that is now part of many NIH grant applications. The last two topics, administrative budget supplement and competing budget supplement, are relevant to later requests to supplement the initial award amount.

Direct costs versus indirect costs. Direct costs comprise those expenses that are directly related to conducting a research project. They include salaries, employee benefits, equipment and scientific instruments, consumable supplies such as printer paper and pipettes, reagents, laboratory computers, and postage. Indirect costs (informally termed "overhead") comprise the expenses that are paid to your institution by the funding organization to support your research but that can't easily be charged directly to a specific grant. These include administration, utilities, computer infrastructure, building maintenance, security, and custodial services. These costs can be from 10 percent to 80 percent of the total direct costs of a research grant. Generally, an institution's administrators negotiate indirect costs, on behalf of the investigator, with the funding organizations (such as NIH or the National Science Foundation) that allow these costs. The organization then provides funds for indirect costs to the institution, along with funds to cover direct costs charged to the research grants. In general, beginning investigators need not be concerned about indirect costs. However, you should be aware that a significant part of the budget for a large funding agency may include indirect costs; the more paid to institutions for indirect costs, the less available for direct costs for investigators and their research projects.

Modular grants. To simplify the budgeting process, research budgets are now requested in units, or "modules," of $25,000. This applies to all investigator-initiated grants (R01, R03, R15, and R21) with direct costs of up to $250,000 per year over the period of the award (see *http://grants.nih.gov/grants/oer.htm*). The number of modules can differ from year to year. For example, acquisition of equipment can make first-year costs higher than those for subsequent years. Request what you need, but be sure to justify that amount.

Administrative budget supplement. This budget request covers unforeseen expenses that arise, generally because initial budget assumptions have changed. Examples are increases in the cost of isotopes or animal care. Administrative supplements are also offered occasionally for special purposes. For example, you may be able to get an administrative supplement to pay for a minority student to work in your lab. These requests are submitted to the I/C program staff rather than to the CSR for peer review. If you have questions about the appropriateness of this type of request, ask your program officer.

Competing budget supplement. Competing continuation applications are designed for the principal investigator who wants to modify the scope of approved work (e.g., by adding an aim or following an exciting lead). These requests are subject to the competitive peer-review process, usually through the same study section that reviewed the initial application. If you're considering this mechanism, ask your program officer about the feasibility of getting those funds from the sponsoring I/C.

More advice on laboratory budgets can be found in the resources listed at the end of this chapter.

Equipment: What You Should Know

Keep in mind the following:

- Cost sharing has many benefits. Consider arranging for your department or institution to share equipment costs.
- If you need new equipment to pursue your research, ask for it on your renewal application. *Never request major equipment funds in the last year of the grant.*
- Your institution owns equipment funded by your grant only after the award period ends. If you're the principal investigator and you relocate, the equipment generally goes with you.
- If you're in doubt about anything related to equipment, ask a grants management specialist at your institution.

You may find help with equipment costs through the Shared Instrumentation Grant Program (S10) or the Small Instrumentation Grants Program (S15) run by NIH's National Center for Research Resources. For more information about these programs, visit *http://www.ncrr.nih.gov*.

Submitting Your Application

Follow instructions for mailing. Applications must be received by or mailed on or before the published receipt date. It's appropriate to send a courtesy copy of your application to the I/C's program officer.

Confirmation letter. NIH will send you a confirmation of receipt, which is also called an assignment notification letter. Review it carefully to make sure all information is correct and you have no concerns (e.g., about assignment to a study section other than the one you requested). The letter will include the following items:

- An application number with codes for the type of grant (such as R01), the assigned I/C, and an identifying application ID number. The two letters in the ID number denote the primary I/C to which the application has been assigned.
- The assigned SRG (or study section)
- The name of the SRA and contact information

The letter will also outline the expected timetable for review and funding decisions and explain who to contact if you have questions.

New data. If new data become available after you have submitted the application, contact the SRA of your assigned study section. You may be allowed to submit this additional information. The SRA can tell you how much to send, what format to use, and when and where to send it.

Interpreting the Summary Statement

After the study section meeting, the SRA will draft a summary statement (see "Behind Closed Doors: Demystifying the Study Section," page 135). Usually, the summary statement is straightforward and will tell you whether your grant is likely to get funded or not, but in some cases, you may need help interpreting it. For example, if your summary statement recommends revision and resubmission, do the reviewers really want to see it again? Or have they politely refrained from stating plainly that they consider your hypothesis untenable, your expectations excessive, or your approach extremely flawed?

The program officer, who usually attends the study section meetings or enlists a colleague to do so, can help you interpret the results of the scientific review. If the program officer wasn't present, he or she can call the SRA for guidance. Your institutional mentor or grant committee can also help you evaluate the summary statement. After the national advisory council meeting, you can discuss the potential for funding or revisions with the program officer.

Occasionally, mistakes are made during the review process. If you believe that the reviewers criticized you for information that they overlooked in your application or think the review was flawed for other reasons, consult the program officer about the possibility of appealing the study section's decision. Although this action is sometimes appropriate, it's usually better to address review comments and resubmit your application. Follow the program officer's guidance on this matter.

If the reviewers thought your starting hypothesis was seriously flawed, don't waste your time revising and resubmitting the application. Instead, learn as much as you can from the summary statement and discussion with the program officer and your colleagues, reconsider your project and approach, and write a stronger application the next time.

Resubmitting Your Application

If your application is not immediately funded, remember that with an NIH funding average of 25 to 30 percent, many applications aren't funded the first time. If the program officer thinks it's worthwhile for you to revise the application, keep the following points in mind:

- Reviewers of amended applications get to see the summary statement from the previous reviews.
- Always treat review comments respectfully.
- Respond to all suggestions and comments, even if you don't agree with them.
- Be explicit about changes: Mark each section of the revised application where you have addressed reviewer critiques.
- Provide any additional data that are now available and update your publication list, if necessary.
- Resubmit the revised application by the due date. Your revised application now begins its journey through the review process all over again, along with the next batch of new submissions from other applicants.

Although your first instinct may be to request that your revised application be assigned to a different study section, you would need a compelling scientific reason for that request to be honored. Further, there's always the possibility that a different study section might find additional reasons to criticize your application.

A revised application supersedes the previous version, erasing the earlier score and pushing you back farther in line in the funding decision-making process. However, as the funding cycles progress and I/C staff have a clearer idea of what remains in their award budget for that fiscal year, they can reactivate the previous version if they find that the score on your initial application looks promising for funding (see "Review and Funding Cycles," page 137). If you submit a revised application and the program officer later tells you to withdraw it because your funding chances now look good, do so.

How many times can, or should, you revise and resubmit the same application? NIH policy is that after a second revision, you must reconsider your project and approach and submit a new application.

RESOURCES

NIH I/Cs and Offices

General information, *http://www.nih.gov/icd/*

NIH Peer Review: Process, Forms, Guidelines

CRISP, a searchable database of federally funded biomedical research projects conducted at universities, hospitals, and other research institutions, *http://crisp.cit.nih.gov*

Overview of peer-review process, *http://www.csr.nih.gov/review/policy.asp*

Study section rosters, *http://www.csr.nih.gov/Committees/rosterindex.asp*

Grant application forms, *http://forms.psc.gov/forms/PHS/phs.html*

Preparation instructions, *http://grants.nih.gov/grants/funding/phs398/phs398.html*

Office for Human Research Protections, *http://ohrp.osophs.dhhs.gov*

Office of Laboratory Animal Welfare, *http://grants.nih.gov/grants/olaw/olaw.htm*

NIH Funding Opportunities

Grants and Funding Opportunities, *http://grants.nih.gov/grants/index.cfm*

Guide to Grants and Contracts, *http://grants.nih.gov/grants/guide/index.html*

Grants site map, with links to other relevant sites,
http://grants1.nih.gov/grants/sitemap.htm

Office of Extramural Research, *http://grants.nih.gov/grants/oer.htm*

Other Sources of Funding Information

FedBizOpps, an evolving database of all federal government granting programs of more than $25,000, *http://www.fedbizopps.gov*.

GrantsNet, maintained by the American Association for the Advancement of Science, *http://www.grantsnet.org*.

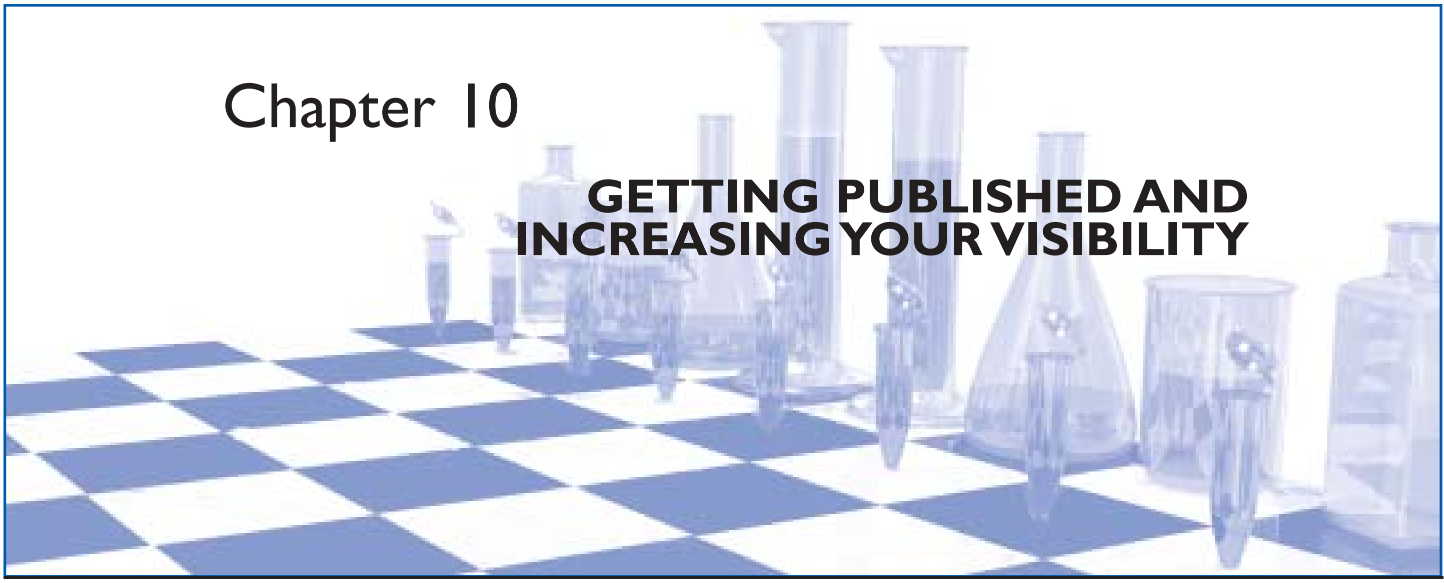
Laboratory Budgets

Brown, Megan, T. "Preparing and Managing Your First Lab Budget: Finance 101 for New Investigators." *Science*'s Next Wave (October 22, 1999), *http://nextwave.sciencemag.org/cgi/content/full/1999/10/20/4?*.

Harmening, Denise M. *Laboratory Management: Principles and Processes*. Upper Saddle River, NJ: Prentice Hall, 2003.

McClure, Michael. "From Science Fair to Science Fare, Part 2: Establishing a Revenue Stream." *Science*'s Next Wave (February 28, 2003), *http://nextwave.sciencemag.org/cgi/content/full/2003/02/27/3*.

budget
publications



Chapter 10

GETTING PUBLISHED AND INCREASING YOUR VISIBILITY

This chapter is based on the session "Getting Published" that was held at the BWF-HHMI Course in Scientific Management. The session was organized by Jim Austin, Ph.D., American Association for the Advancement of Science, with a presentation by Angela Eggleston, Ph.D., Cell Press. Additional information was obtained from Mark A. Hermodson, Ph.D., Purdue University; Tom Misteli, Ph.D., National Cancer Institute, National Institutes of Health; and some of the resources noted in this chapter.

Your scientific success hinges on your ability to produce a body of publications that your colleagues will notice and respect and that granting agencies and your tenure committee will accept as proof of your research accomplishments. You are also, to some extent, responsible for the publication success of your postdocs and graduate students. After several years of graduate school and postdoctoral research, you should be familiar with writing scientific papers and the peer-review process for scientific publishing. This chapter provides some tips on planning for publication and some tricks of the trade to help you get your work published. It also offers some pointers for increasing your visibility in the scientific community.

A BRIEF OVERVIEW OF SCIENTIFIC PUBLISHING

This section reviews some of the basics of the publishing process.

Types of Journals

Within the broad category of peer-reviewed journals, individual journals vary in the audience they try to reach and in the scope of coverage they provide. For example, some journals—typically the top-tier journals—focus on a broad scientific audience. Others are deliberately narrower in scope, publishing research within a scientific specialty. In addition, a hierarchy exists within the world of scientific publishing. Some journals are more prestigious than others are, a situation that is dictated in part by each journal's *impact factor*—a measure of how frequently papers published in that journal are cited in other journals (see box "A Word About Impact Factors," on page 152). The more prestigious the journal, the more competitive its publication process is.

Communication Formats

In scientific journals, primary research holds center stage, although significant space is often allocated to reviews and commentaries. Depending on how complete the study is, original research can be published in a variety of formats, including full-length articles, brief communications, technical comments, or even letters to the editor.

As a beginning investigator, you will need to concentrate on getting your research published as peer-reviewed, full-length articles. These are by far the priority of both tenure committees and the study sections of granting agencies. Technical comments and notes count for very little in most fields.

A well-written and useful review may be worth the investment of your time, particularly if you've been writing grants and have collected all the literature anyway; however, a review does not carry the weight of original research. Good reviews tend to get cited frequently by other scientists, which would increase your citation index (a measure of how many researchers cite your work); this sometimes makes a difference with tenure committees. However, reviews are extremely labor-intensive, and to do them well, you need the breadth and depth of knowledge that generally comes only with long experience. Writing a review that reveals your lack of expertise could be embarrassing, so be careful.

As your career progresses, you may want to consider other opportunities to express your views—in letters, comments, and discussions of scientific trends. Most readers peruse this "front matter," and contributing to it gives you quick and wide visibility. In the top-tier journals, however, front matter tends to be commissioned by the editors and is thus reserved for established investigators.

A Word About Impact Factors

In 1975, the Institute for Scientific Information began to publish *Journal Citation Reports* (*JCR*) (*http://www.isinet.com/isi/products/citation/jcr*), a database of quantifiable information designed to indicate the relative importance of a journal within its subject category. One of several types of data published in *JCR*, the impact factor is a measure of how frequently the "average article" in a given journal has been cited in a particular year or other time period. The impact factor, which is updated annually, is calculated by dividing the number of current-year citations by the number of citable items published in that journal during the previous two years.

Although the impact factor is often used to provide a gross approximation of the prestige of a journal, many other factors can influence a journal's impact and ranking. For example, review articles are generally cited more frequently than research articles are, because the former often serve as surrogates for earlier literature, especially in journals that discourage extensive bibliographies. The inclusion of review articles in a journal will, therefore, increase its impact factor.

The Editors

Some journal editors are professional editors who trained as scientists but no longer work in a lab. Others are working scientists who have their own research programs but also serve for a period of time as editors. The top-tier journals in the biomedical sciences, such as *Cell*, *Science*, and *Nature*, are staffed by professional editors. When talking to a professional editor about your work, be sure to take the time to highlight the general interest of your paper and explain the nuances of the science. An editor who is also a working scientist is more likely to already know these things.

PLANNING FOR PUBLICATION

Because publishing original research papers is critical to your career, this section focuses exclusively on submitting and publishing these types of papers.

Knowing When to Publish Your Research

Your tenure committee will want to see that you have published at least one paper a year in a highly ranked journal in your field as a senior author. (Some departments and institutions may expect several papers per year; make sure you discuss these expectations with your mentor.) If you have one or more postdocs who want to pursue research careers, each of them is under similar pressure to publish. To obtain a faculty position, it is usually necessary that a candidate be first author on two or more papers, at least one of which is a high-impact paper.

> *The number of papers needed for promotion has encouraged short, scientifically incomplete papers that do not serve the scientific community well—"slicing the salami thin" is a description of that in the publishing business. But it is a fact of life.*
>
> —Mark Hermodson, Purdue University

Research projects have a natural point where it makes sense to publish (see box "Creating an Integrated Research and Publication Plan," page 154). However, you may want to write up your results before you reach this point. If there is competition in your field and you wait to publish, you run the risk of being "scooped"; in this case, you would have to publish your research in a journal that is not as prestigious as the one you had initially envisioned. Also, if you wait to obtain complete results, you may not be able to accomplish your goal of publishing at least one paper a year.

In deciding when to publish, you will have to balance several considerations, but try to resist the temptation to rush into print. Remember, the quality of your publications is what matters most in the long run. A paper that is incomplete or carelessly put together is less likely to be accepted for publication and will be an inefficient use of your time. Even worse, incorrect results will damage your reputation.

> *Writing up an incomplete or flawed story is not time-effective, since writing a good or bad paper generally takes the same amount of time.*
>
> —Tom Misteli, National Cancer Institute

Choosing a Journal

Because most papers today have several authors, the choice of where to publish often involves considerable negotiations. All authors typically want to publish in the most prestigious journal that is likely to accept their paper, but views on which journal is best will differ. Negotiations will also depend on who is involved. As the principal investigator, you will want to take into consideration the suggestions of students and postdocs in your lab; however, you will generally make the final decision. Decisions about where to publish may become more complex when two or more principal investigators have coauthored a paper that involves extensive interlaboratory collaboration.

Creating an Integrated Research and Publication Plan

There is a balance to be struck between trying to produce a "dream paper," which may never get done, and sending out a set of fragmentary observations. One way to find this balance is to integrate your plans for publication into your research plans. In her book *At the Helm: A Laboratory Navigator*, Kathy Barker suggests strategies for doing this. As you decide on the long-term goals of your research and on the series of experiments or calculations you want to undertake, Barker suggests that you envision these experiments or calculations as components of a published manuscript or series of manuscripts. Think graphically; imagine how each set of results will be displayed in a figure, graph, or table. Put your ideas in writing at the outset, sketching out the hypotheses you want to pursue, the methods you intend to use, and the results you hope to get.

By integrating research planning, the development of displays of your data, and interpretive writing, you force yourself to focus your energy and you move your project forward. The questions you generate as you analyze and write up the results of each experiment should suggest additional clarifying experiments, which you should also express graphically. As you write, you will uncover gaps in information and shaky conclusions. Eventually, you should be able to decide that you have a set of results that warrants publication.

Here are some questions that can help guide your decision:

- Are my results sufficiently groundbreaking, and do they have enough general appeal, to be considered by one of the top-tier scientific journals? Do I have a larger story that makes my results really exciting?
- Even if my results are not earth-shattering, have I taken an interdisciplinary approach, making the findings interesting to scientists in several fields and therefore appropriate for a general journal?
- If my results are primarily of interest to my particular scientific specialty, which journals reach the members of that specialty? Within this group, which journal or journals have included articles on my particular subject area in the past couple of years?
- Would any journals be particularly interested in my subject because it fits into a theme they have been pursuing? Some journals, and some editors, pursue their own special interests over time.

The top-tier journals receive far more submissions than they can publish. For example, *Nature* rejects about 95 percent of the biomedical papers it receives. Be realistic about your chances. You will lose precious time by submitting your paper to the wrong journal.

It helps to ask trusted colleagues where they think your paper should appear. If they are frequent reviewers for several journals in your field, they will have a good idea of what the standards are for each journal.

Making Your Pitch

To make sure you write your paper for the right journal, you may want to submit an initial query to your target journal to gauge its interest in your work. Most journals have guidelines for submitting so-called presubmission inquiries; check journal Web sites for this information. If the journal does not provide guidelines, send an e-mail to one of the editors. (Try to find out the name of the editor who handles papers in your area.)

A presubmission inquiry usually includes the following:

- An abstract stating the purpose of the project, methods, and main findings and conclusions. This abstract can be slightly longer than the abstract of a typical research paper and may include citations of relevant journal literature. Make sure that the abstract is clear to nonspecialists and that they will be able to understand what the scientific advance is.
- A cover letter briefly describing what questions led you to your research project, what you did, why you think your findings or methodology is significant, how your findings advance the field, and why they are of special interest to that journal's readers. Limit the cover letter to no more than 500 words.

Presubmission inquiries are typically considered within a few days; when that time has elapsed, follow up with a telephone call or e-mail. If you contact an editor by phone, use the opportunity to make your pitch. Be sure to allude to the larger context of your research—the big picture that makes your particular effort meaningful.

You can expect a reply of either "we're not interested" or "send the full manuscript." A positive response to a presubmission inquiry is *not* a guarantee that the manuscript will be sent out for formal peer review. The editor will want to see the actual paper before making that decision.

GETTING YOUR PAPER PUBLISHED

Writing Your Paper

Once you have decided where you want to submit your manuscript, review the journal's editorial guidelines (available from the journal's Web site or directly from the editor) and follow them carefully.

The main consideration when writing a paper is to clearly describe your most important findings and their impact in your field. Don't let your manuscript look like a compilation of lab data; make sure the reader can understand how you have advanced the field of research. But don't overdo it—claiming that your work is more important than it really is earns little more than contempt from reviewers.

Assign the task of writing the first draft of the paper to the student or postdoc who will be first author. Encourage that person to prepare the figures, tables, and legends first, because a scientific paper is best written with the final form of the data in front of the writer. Then work with the author to get the paper into shape. Although this may not be the most efficient way to write a paper, it is important for people in your lab to get experience and feedback on writing papers.

Once you have a good first draft, send it to colleagues in your field and in your department for review. Have it proofread by someone in your lab with access to your data and the documents you have cited. The last thing you want to do is to appear careless; doing so will raise suspicions about the quality of all your work. It is also a good idea to give the paper to someone outside your field to see whether they understand its importance.

Three particularly important parts of your submission are the title, abstract, and cover letter.

Title and abstract. Create these two elements after the manuscript is complete. The title should summarize the take-home message of your paper. The abstract should briefly summarize the paper and should stand on its own. Describe the experimental question, the methods, the main results, and the conclusion. Unless the main point of the paper is a new technique, methods should be limited to a sentence or a few words. Keep in mind that the abstract will announce the existence of your work to people who may not have time to read your paper. If the abstract attracts their attention, they could be induced to read your article, rather than passing on to the next abstract. Also note that your title and abstract will be used as the basic tools for the retrieval of your paper from electronic and paper libraries.

Cover letter. The cover letter should explain why the paper is significant and why you think it is appropriate for the journal to which you are submitting it. The letter should cite a major question in your field and describe how your work helps answer it. You may want to cite other papers the journal has published in this field or provide other reasons why the journal's readership would find your work of interest. The letter of introduction is the place to mention whether there is competition in the field that could lead to your being "scooped," as well as to include a list of colleagues who have reviewed the paper and any information necessary to ensure a fair review process. Most journals will give you an opportunity to suggest people who are qualified to comment on your work and to exclude one or two particular individuals who may be competitors and should not be reading about your work before it is published. Be sure to take this opportunity.

Many books and articles that explain how to write scientific papers are available in print and online. (Some of these are listed in the "Resources" section at the end of this chapter.)

Submitting Your Paper

Electronic submission is becoming more prevalent: Each journal has its own requirements with respect to such matters as preferred file formats for text and figures and the procedures for uploading files. Consult the journal's Web site for specific instructions and be sure to follow them.

Regardless of whether they receive a paper manuscript or an electronic version, most journal editors will let you know that they have received your manuscript and how long you can expect the review process to be.

Navigating the Review Process

The reviewers of your paper will be chosen by the journal's editor, who will take into account any names you have suggested, his or her own knowledge of the field, and a literature search.

Receiving the reviewers' comments. A paper is rarely accepted after the first round of review. When you receive the editorial decision and the reviewers' comments, you will have to decide how to proceed. Sometimes the editors will indicate they would like to publish your work, provided that you make a few minor revisions or do a few additional experiments. In other cases, the editors will say that the work is potentially interesting but too preliminary or that it has significant flaws that preclude its publication. Another possibility is that the reviewers will advise the editors not to publish the work even if it is revised, because it is either not sufficiently novel or it does not fit the scope of the journal. Most editors are happy to talk to you by telephone to help you assess whether you should revise and resubmit your paper or try another journal. In any event, it is important to remain unemotional during such conversations.

Responding to reviews. Do not react defensively. Focus instead on the substance of each editorial comment. Value good advice wherever you find it. Read the reviews carefully and communicate your responses in writing to the editor. It is a good idea not to respond as soon as you hear from the editor. Let a couple of days go by. A hastily written and emotional response will hurt your chances for resubmission.

If the reviews include a request for additional information that will require a few more experiments, carry them out and send your response to the editor. You can make the process easier by repeating each comment, stating your response, and indicating explicitly where in your paper you are making a recommended change.

If the main problem is that the manuscript does not convey the importance of the work, you may want to rewrite it and add more data. You might want to check with the editor first to make sure this is an appropriate course of action.

In the end, you will have to do a cost-benefit analysis. If you believe that satisfying all the reviewers' concerns would bog down your research program in unnecessary experiments, you may have no choice but to take your paper elsewhere.

If You Are Asked to Review a Paper

As your relationships with journal editors develop, you may be asked to review manuscripts submitted by other scientists. Take the task seriously. Do the reviews thoroughly and promptly. If you don't have time or don't think you have the right expertise, let the editors know right away. They will not hold this against you. A late or weak review, however, could hurt your reputation with the editors. The benefits of serving as a reviewer are potentially great. Not only will you learn about others' research, you will improve your own critical skills and confirm your standing as a knowledgeable scientist in the eyes of the editors. Your own future papers will be taken more seriously if you do good reviews.

You will be asked not to reveal the contents of any article reviewed and be reminded that you should not use your knowledge of the prepublished results to further your own research. Take this admonition seriously—it is essential that you respect the confidentiality of the review process. If you have a conflict of interest that precludes you from reviewing an article (e.g., you are directly competing with the author of the article you are reviewing or the author is one of your former postdocs), stop reading the paper and let the editors know immediately. They will not be pleased if they find out about a conflict of interest after you have reviewed the paper.

If you think a criticism is off the mark or that a requested additional experiment is unreasonable, write a rebuttal letter covering the relevant issues. Ultimately, you are the person best acquainted with the details of your work and the limitations of your research tools. Keep your emotions in check; never demean the reviewers. The reality is that reviewers, especially those who manage their own laboratories, sometimes work under unrealistic time pressures. Occasionally, the reviewer selected may not have the expertise to judge a paper competently. Whatever the case, do not question a reviewer's expertise. If you think a reviewer missed an important point, politely tell your editor, who has the option of identifying additional reviewers for your paper if doing so seems warranted.

Submitting your paper to another journal. If you are advised that your paper isn't appropriate for the journal to which you have initially submitted it (e.g., it is not sufficiently novel or does not have the right focus), the best course is usually to select another journal. In some cases, you may not want to inform editors of the second journal that the manuscript was submitted elsewhere and rejected—it might prejudice the process. For example, if your paper was rejected by *Nature* and you resubmit it to *Science* (or vice versa), don't let the editors of the second journal know. These journals compete for the best papers and don't want to publish each other's rejections. If, however, your paper was reviewed by *Nature* or *Science* and the reviews were generally positive but the editor did not feel the paper had a sufficiently high impact value for a top-tier journal, you may be able to use the reviewers' comments as leverage for your next submission to a second-tier journal. Ask the first journal's editor to support the resubmission, and tell the second editor that your paper has already been reviewed. The second review process may be expedited.

Regardless of your course of action, never send a rejected manuscript without changes to a second journal. If, as is likely, the same reviewers receive it a second time, they will be annoyed to see that you have ignored their comments.

INCREASING YOUR VISIBILITY

Your patience and persistence have paid off, and your article has been accepted by a good journal. Now you can use your newly minted publication as a tool in a legitimate effort at self-promotion. You want to become known to your scientific colleagues nationwide. Here are some things you can do:

- Announce the publication on your personal Web site and in e-mail correspondence with your friends. Consider making it available in PDF format.
- Give a workshop or a brown-bag presentation at your own institution on the research described in your article and your future research plans. Doing so is relatively easy and is good practice.
- Call your friends at universities around the country and offer to give a talk on your research at their institutions or at conferences they are organizing. However, don't invite yourself to a meeting by writing to the organizers if you do not know them. You might come across as arrogant and put people in the awkward position of having to turn you down.
- Once you have an invitation, take it seriously. Prepare and rehearse your talk.

> *I learned early on that if you want to be promoted, you need to get a national reputation. This means that you have to be invited to give talks at universities around the country and at national conferences. The people listening to you might be the ones recommending you for promotion; they might be sitting on an NIH study section when your grant comes up for review; or they might be potential collaborators. Or they might be graduate students who would consider coming to your lab as postdocs. So how do you get these invitations when you're just starting out? Well, you can't be shy. You have friends all over the country who are also young faculty and carrying out work that would be of interest to your department colleagues. Call them up and make a deal: "I'll invite you if you'll invite me."*
>
> —Thomas Cech, HHMI

- Consider going public. Contact your university public relations office for help in contacting the media. It is in the university's interest to have the good work of its scientists publicized.
- If your research was supported by an outside funder, let the appropriate staff at the funding organization know about the publication as soon as possible.

Getting your work published and promoting your publications are essential, interrelated tasks of scientific communication. So think "big picture" and "long term" when working on your publications, presentations, and other efforts to bring your work to the attention of others in your field.

RESOURCES

Curran-Everett, Douglas. "The Thrill of the Paper, the Agony of the Review: Part One." *Science*'s Next Wave (September 10, 1999), http://nextwave.sciencemag.org/cgi/content/full/1999/09/08/6.

Curran-Everett, Douglas. "The Thrill of the Paper, the Agony of the Review: Part Two." *Science*'s Next Wave (September 24, 1999), http://nextwave.sciencemag.org/cgi/content/full/1999/09/10/1.

Davis, Martha. *Scientific Papers and Presentations*. San Diego: Academic Press, 1997.

Day, Robert A. *How to Write and Publish a Scientific Paper*. 5th ed. Phoenix, AZ: Oryx Press, 1998.

Dee, Phil. "Yours Transferably: Your First 'First-Author' Paper: Part One—Writing." *Science*'s Next Wave (February 15, 2002), http://nextwave.sciencemag.org/cgi/content/full/2002/02/12/1.

Dee, Phil. "Yours Transferably: Your First 'First-Author' Paper: Part Two—The Act of Submission and Peering at the Review Process." *Science*'s Next Wave (March 15, 2002), http://nextwave.sciencemag.org/cgi/content/full/2002/03/13/3.

Matthews, Janice R., John M. Bowen, and Robert W. Matthews. *Successful Scientific Writing: A Step-By-Step Guide for the Biological and Medical Sciences*. 2nd ed. Cambridge: Cambridge University Press, 2000.

Chapter 11

UNDERSTANDING TECHNOLOGY TRANSFER

This chapter is based on the session "Technology Transfer" that was held at the BWF-HHMI Course in Scientific Management. The session was organized by Andrea L. Stith, Ph.D., Howard Hughes Medical Institute (HHMI; now at the Federation of American Societies for Experimental Biology). The panelists were Martha J. Connolly, Ph.D., EntreMed (now at the Maryland Technology Enterprise Institute); Francis J. Meyer, Ph.D., A.M. Pappas & Associates; and Christopher T. Moulding, HHMI. Additional information was obtained from Heidi E. Henning, J.D., HHMI; Tony G. Waldrop, Ph.D., University of North Carolina–Chapel Hill; and some of the resources noted in this chapter.

Two decades of explosive growth in biomedical science have quietly revolutionized the role of academic investigators in the commercialization of research results. Patent applications for promising discoveries, once the near-exclusive domain of industry, are now filed routinely by research universities. Through the process known as technology transfer, these patents are licensed to companies for development into marketable products or services.

The technology transfer guidelines at your institution will be based, at least in part, on federal and state laws, regulations, and guidance. This chapter provides an overview of the technology transfer information most important to academic scientists. The information should be viewed as a supplement to the information in your institution's faculty handbook and its intellectual property policies.

The chapter reviews the role of the university's Technology Transfer Office (TTO) and covers the ways in which a university's intellectual property (IP) is protected, the process for bringing an invention to market, and diverse types of legal agreements. Conflicts of commitment and interest are also discussed.

UNIVERSITY TECHNOLOGY TRANSFER OFFICES

In 1980, the U.S. Congress passed the Bayh-Dole Act to jump-start the transfer of inventions from federally funded academic laboratories to the public. As a result, today most academic research institutions have TTOs that, with the help of the inventor, evaluate an invention for potential use and marketability and handle the forms, filings, negotiations, and follow-up of technology transfer. Most universities' TTOs follow the provisions of the Bayh-Dole Act, regardless of whether the research is federally funded. This means that if you make a discovery with potential commercial value, your university will own and control the IP, but you will get a percentage of any resulting licensing income, including royalties.

Soon after taking your post at your new institution, you should meet with the TTO staff. They can tell you about what they do and how they can help you.

THE TECHNOLOGY TRANSFER PROCESS

It Starts with an Invention

For a scientist, most technology transfer begins with an invention: a new and useful process, a machine, an article of manufacture, composition of matter, or any related improvement to these. The invention itself has two steps: conception and reduction to practice. Reduction to practice is further subclassified into two types:

- Constructive reduction to practice involves filing a patent application even though an invention isn't yet physically reduced to practice or "made." The information in the application should make it possible for a person of ordinary skill in the art to make and use the invention without undue research or experimentation.
- Actual reduction to practice requires a working model demonstrating that the invention will work as intended.

Moving from Invention to License

The journey from invention to license can be frustratingly long and very expensive. The following are typical steps:

- *Discussion:* The inventor informally discusses the invention with the institution's TTO. These discussions may help the inventor decide whether to proceed with filing an invention disclosure. In some cases, further work on the invention may be advisable before proceeding.
- *Disclosure:* The inventor reports the invention to the TTO using the institution's standard disclosure form.
- *Evaluation:* The TTO assesses the invention for patentability and commercial potential.
- *Filing and commercialization decisions:* The TTO may ask the inventor to do further work on the invention before proceeding, may file a patent application if the invention has commercial potential and appears to be patentable, or may decide to market the invention without filing for patent protection. If the TTO is not excited by commercialization prospects, it may "waive title," in which case ownership rights may be released to the inventor. Some universities waive title only on certain conditions—for example, an inventor may be asked to reimburse patent costs or pay a percentage of any income from the invention or both.

Commonly Used Abbreviations

CIP: Continuation-in-part (patent application)
COI: Conflict of interest
IP: Intellectual property
ITU: Intent to use
MTA: Material transfer agreement
TTO: Technology Transfer Office
USPTO: United States Patent and Trademark Office

- *Marketing:* The TTO will contact potential licensees.
- *Licensing:* The TTO will negotiate and manage licenses to companies.

At the end of this process, approximately 30 percent of inventions reported to the TTO will be licensed.

Should I File an Invention Disclosure?

Deciding whether to file a disclosure with the TTO to report a discovery made in your lab may not be a clear-cut matter. Some of the factors that might encourage you to file include the following:

- The invention could lead to a useful diagnostic or pharmaceutical, and patent protection would be necessary to convince a company to incur the costs of development and clinical trials.
- You and your university, department, and colleagues could profit from a patent both financially and in terms of enhanced reputation.
- If you pass on the opportunity to file a disclosure, there's no going back. Later on, it may not be possible to obtain patent protection.

Before filing a disclosure, you should also be aware of the following considerations:

- Dealing with the TTO, patent attorneys, and eventually, licensees, can be very time-consuming.
- Filing for patent protection can delay publication; you will want assurances from the TTO that the delay will be minimal (often 30–60 days is reasonable).
- If you can't identify a specific use and potential licensees, it may be unrealistic to expect that the TTO will be able to solve this problem.
- Be careful with patents on research tools; you will want your invention to be made broadly available, not restricted for the use of a few.

TECHNOLOGY TRANSFER: THE LEGAL TERMS AND AGREEMENTS

This discussion is an overview of some of the common terms and legal agreements used in connection with technology transfer. For more information and project-specific assistance, consult your institution's TTO.

Patents

The U.S. Patent and Trademark Office (USPTO) grants three types of patents:

- Utility patents (20 years) may be granted to anyone who invents or discovers any new and useful process, machine, article of manufacture, composition of matter, or any new and useful improvement to these.
- Design patents (14 years) may be granted to anyone who invents a new, original, and ornamental design for an article of manufacture.

- Plant patents (17 years) may be granted to anyone who invents or discovers and asexually reproduces any distinct and new variety of plant.

Most patents produced by academic researchers fall into the utility category.

> *Educate yourself about what constitutes public disclosure. Talking to a grad student doesn't, a faculty lecture comes close, and a presentation in a public forum may cost you the patent rights.*
>
> —Martha Connolly, Maryland Technology Enterprise Institute

Question: Are the public disclosure rules the same for foreign patent rights?

Answer: No. If your invention is publicly disclosed before you file a patent application, you lose foreign rights. If you file a U.S. application before the first public disclosure, you have one year from that filing date to file foreign patent applications. A Patent Cooperation Treaty application preserves the right to file in selected foreign countries for 18 months after the one-year period.

What does a patent do? A patent gives the owner or an exclusive licensee the right to exclude others from making, using, or selling the patented invention for a specific period that begins with issuance of the patent. The patent provides protection within the country where the patent is granted. For U.S. patent protection, an application may be filed up to one year after *public disclosure* of the invention, but patent rights outside the United States can't be obtained if public disclosure occurs before a patent application is filed.

Researchers *must* have a clear understanding of what constitutes public disclosure. If something you say or write allows someone else to practice your invention before a patent application is filed, you may have created a bar to filing patents on your invention outside of the United States. Before discussing your discovery in any forum that could be considered public, you may wish to consult your TTO about the proposed disclosure.

What is—and is not—patentable? To be patentable, an invention must be useful, novel, and "nonobvious" to someone of ordinary skill in the art. If you think you have a discovery that meets these criteria, the best approach may be to go directly to your TTO and let the experts take charge from there.

You may want to conduct a "patentability search" of key words at http://www.uspto.gov to screen for similar inventions in the files of patent applications. You can do this yourself, without the aid of a patent professional.

Certain forms of unpatented IP may be licensed to companies by the TTO for commercial use. These kinds of IP include the following:

- *Tangible property:* This can be licensed for compensation but without patent protection; others are not precluded from independently developing the same materials. Examples are cloned DNA, viral vectors, cell lines, seeds, tissues, and organisms.

Who Owns Inventions at a University?

As a condition of employment, U.S. universities require faculty and staff to assign invention rights to the university. A common key phrase in university IP policies is "use of university funds or facilities" in conception or reduction to practice of inventions or development of materials, which extends the institution's ownership to IP of graduate students and guest researchers. In other words, the university owns inventions made by university personnel and may have rights in inventions made by others using university funds or resources.

- *Know-how:* This can be licensed in some circumstances, usually nonexclusively in conjunction with a patent license. Examples are techniques, experimental systems, and special knowledge.
- *Copyrighted works:* Although copyright in scholarly works normally rests with the authors, copyright in other written works may be claimed by the university. Examples are formulas, algorithms, and software, including source code.

In contrast to industry, universities almost never maintain trade secrets, which are antithetical to the knowledge-expanding culture of an educational institution.

The patent application. When the TTO is confident that your invention meets the criteria for being patented and has commercial potential, it's time to prepare a patent application. Like most legal documents, a patent application is best prepared by a specialist—a patent attorney or agent. Universities normally hire patent law firms to prosecute patent applications.

Question: How much does it cost to get a patent?

Answer: Costs vary widely depending on factors such as the patent attorney's time spent and hourly rate, what is being patented, the number of claims in the application, the number of (and reasons for) USPTO rejections, and whether foreign filings are pursued. Preparation costs can run between $5,000 and $20,000 and up, and filing fees and possible prosecution cost between $3,000 and $5,000 and up (sometimes much more). The university pays the fees, but in almost all cases, the first income from the invention is earmarked for reimbursement of these costs. Only then does the income-sharing formula for the inventors kick in.

The patent attorney is likely to need input both from the inventor(s) and the TTO in order to prepare a patent application. You can expect to speak with the patent attorney several times over the course of the patent process. You will probably also be asked to review draft documents. The major elements of a patent application are the abstract, background/introduction, specification (how to practice), and claims.

In preparing the patent application, the patent attorney will need to make a determination of who should be named as inventors. It is important that this determination be accurate, because a patent may be invalid if the named inventors are not correct (either because an individual who did not make an inventive contribution is named or because an individual who made an inventive contribution is not named). The inventors may differ from the authors of the paper that describes the invention. For example, a postdoc who joined the project after the inventive steps had occurred and then provided supporting data might be a coauthor but not an inventor. Normally, only the named inventors share royalties under institutional policies.

What happens to the patent application? From the time the application is filed, the USPTO usually takes 12 to 18 months to complete its examination and issue an

"Office Action." The first Office Action is generally a rejection. The applicant is then required to narrow patent claims and justify the novelty or nonobviousness of the invention in the light of prior art identified by the USPTO. Subsequent Office Actions often result in issuance of a patent, but this process takes an average of about three years.

Technology Transfer and Faculty Recruitment

Increasingly, TTO staff are part of the university recruiting team. When faculty candidates compare employment offers, many often consider the university's commercialization record and policies regarding income sharing.

Commercialization record. Licensing and commercialization success can be strong selling points, along with the TTO's track record in crafting advantageous terms.

Income sharing. Formulas differ for distributing IP-related royalty and equity income, but a common distribution is 40 percent as taxable income to the inventors (split if there are multiple inventors), 40 percent to the inventors' departments for education and research, and 20 percent to the university for management of the invention and support of technology transfer efforts. However, some universities give the inventors as much as 50 percent of net licensing income, and others give the inventors as little as 20 percent.

An alternative is a provisional patent application, a streamlined version that can be filed without some of the time-consuming formalities of the standard form. The USPTO doesn't examine this type of application, a patent can't be issued directly from it, and it expires automatically one year after its filing. During that year, the university can file a regular patent application. So what's the point? This option has at least three benefits:

- Temporary filing protection can be secured for your invention for less money (less time for an attorney and a filing fee of only $80 for a small entity or a university).
- If filed before a public disclosure, a provisional application preserves the right to file for foreign patent protection.
- The one-year term of a provisional application doesn't count toward the 20-year (or other) patent term.

Many applications filed by universities are provisional, even if the application is extremely thorough. The reason: This option buys valuable time. The technology is usually at an early stage of development. A year later, the TTO can file a regular application that includes not only the invention described in the provisional patent application but additional results developed in the interim, which may result in approval of broader claims.

Despite its conditional nature, a provisional application shouldn't be a sloppy filing that the TTO plans to fix during the following year. It should be prepared by a patent attorney or agent and held to the same standards as the work that led you to this point. In addition, be aware that in some cases in which a provisional patent is filed, TTO staff may not yet have done a thorough search for competing or similar patents. You should find out whether such searches have been conducted and make sure a patent attorney examines the results.

Licensing Agreements

In technology transfer terms, a license is a legal contract that allows a company to make, use, and/or sell a university's invention. Through a licensing agreement, someone agrees to pay for the use of IP that someone else (in this case, the university)

Question: Do I have any say in where my invention is licensed?

Answer: Although your university has ultimate authority regarding the choice of licensee and the license terms, you will probably have some control over where your invention goes. In the licensing process, a full faculty member's preferences will likely carry more weight than a post-doc's. In some cases, a company will already have licensing rights because it provided research funding or materials. If it exercises those rights, the university may not be able to license the invention to any other company, regardless of the university's or inventor's preferences.

owns—under strictly defined terms and conditions that are specific to each license—but the university maintains its ownership rights to the IP. In other words, a license allows people (or entities) to make, use, or sell something they don't own without being prosecuted. If special know-how developed by the inventors is needed to "practice" the invention, it's often included as part of the licensing agreement.

Licenses can be exclusive or nonexclusive. An exclusive license grants the right to use the invention to only one licensee. Exclusive licenses usually allow the license holder to sublicense the invention to others for a fee. These sublicenses generate "pass-through royalties" as an additional source of income to the university. A license also can be granted exclusively to one licensee for a specific application, or "field of use," maintaining the university's option to issue licenses for other fields of use.

A nonexclusive license can be granted to multiple companies. The TTO, with the inventor, will decide whether an invention is best licensed exclusively or nonexclusively. Know-how is usually licensed nonexclusively in order to preserve the inventor's right to share the know-how with other scientists informally.

Your TTO will probably handle licensing arrangements for your institution, but keep in mind one point: Many companies often want all future improvements to an invention to be licensed to them. However, universities generally do not license inventions or improvements (unless very narrowly defined) that have not been made. This policy serves as a protection to you, the inventor, to keep from encumbering your future research results. You need to be aware of the tension between the interests of the university and the companies to whom inventions may be licensed.

Negotiating the Agreement

The TTO has responsibility for protecting the university's and the inventor's interests. If the inventor insists on unreasonable terms, some TTOs may be obliged to present them, damaging the negotiating process and the relationship in which all of you will be tied. So, try to refrain from inserting yourself into the negotiating process in this way. During the negotiation, however, it is necessary for you to understand what restrictions an exclusive license may impose on your ability to share data or materials with others.

Option Agreements

An option agreement is a right to negotiate a license—a document that says, "I want to and I hope I can, but I'm not ready yet." It's less complex than a license, relatively easy to negotiate, and may or may not include the financial terms of the expected future license.

Because it's of limited duration (usually 6 to 12 months), an option agreement is a useful mechanism in dealing with start-up companies and their inherent uncertainties. It gives the hopeful licensee an opportunity to secure funds and attract other resources needed for commercial development, and it gives all parties time to evaluate the technology and what each brings to the table and to establish trust.

Material Transfer Agreements

Often as a result of a publication or presentation, other researchers may request materials from your lab—generally a cell line, animal model, research reagent, genetic construct such as a plasmid or phage, or purified proteins. Some institutions require that a material transfer agreement (MTA) be signed and returned before material is sent out. Some send the MTA form with the shipment and consider delivery of the material to be implied consent, whether or not a signed MTA is ever returned. Others may be unconcerned about keeping records for outgoing material (at least when the recipient is another nonprofit institution).

Almost all MTAs for incoming materials require the signature of an authorized representative from the university. Even if an institutional signature is not required by the materials provider, university policy may call for institutional review of the terms anyway. Check with your university's TTO about who needs to approve the terms for and signs MTAs for incoming materials for your lab.

MTAs have distinct uses and caveats according to the entities involved. The following lists address three MTA scenarios: transfer of materials between academic labs, from academia to industry, and from industry to academia.

MTAs covering transfers between academic labs usually have relatively benign provisions. An exception is when the materials have been exclusively licensed to a company that successfully negotiated for restrictions on distribution. Work to avoid this situation because it puts your responsibilities as an author to share reagents at odds with your contractual responsibilities to a licensee. MTAs used for transfers to an academic lab typically and reasonably require that recipients of the materials do the following:

- Use the materials for noncommercial research purposes only.
- Acknowledge the providing scientist in publications.
- Not send materials to third parties without the provider's consent.
- Assume responsibility for damages caused by use of the materials by the recipient.
- Not use the materials in human subjects.

MTAs used for transfers from academia to industry usually do not permit use of the materials commercially (e.g., for sale or to make a commercial product) or in human subjects but allow use for defined internal research purposes. They may also require that recipients do the following:

- Share manuscripts before publication, in addition to providing proper acknowledgment in publications.
- Indemnify the provider for damages caused by use of the materials by the recipient.
- Not send the materials to third parties.
- Pay a fee.

MTAs used for transfers from industry to academia tend to be the most restrictive and difficult to negotiate. They may include the following terms:

- *Ownership:* Beware if the definition of materials specifies that the company will own all derivatives and modifications made by the recipient or if the MTA requires assignment of inventions to the company or provides the company with an automatic nonexclusive license to all inventions. Many institutions try to avoid granting broad "reach-through" rights in new materials or inventions developed by their faculty.

- *Publications:* Beware if the MTA reserves to the company the right to approve or deny publications. More reasonably, the company may require review of manuscripts 60 days or more before submission for publication, and delay of publications for 60 days or more after manuscript submission. At a minimum, most companies want a 30-day prepublication review to protect confidentiality and their investment and to consider filing for patent protection.

- *Reporting:* The MTA may require extensive reporting and sharing of data from the recipient.

The university's TTO will scrutinize the language of an MTA for incoming materials for restrictions like these and weigh the costs and benefits. If negotiations can't alter unacceptable MTA terms, the university may refuse to proceed. Under these circumstances, the requesting university scientist will not be able to get the materials from that provider.

SPONSORSHIP AND CONSULTATION

Through publications, presentations, and personal contacts, the work of an academic investigator might pique the interest of industry. If there's a good fit between the avenue of research and the company's strategic interests, the company may want to buy an option to commercialize the lab's research results or support some of the investigator's research. Or the company may invite the investigator to become an adviser or consultant. The typical mechanisms for doing so are described next.

Sponsored Research Agreements

When a company funds a university laboratory's research, the terms are spelled out in yet another form of legal agreement, called a sponsored research agreement, negotiated by the TTO or the university's Grants and Contracts Office. Most sponsored research agreements will take into account the following guidelines:

- *Project control:* The work should be entirely under the control of the university, not directed in any way by the sponsor.

- *Technical representatives:* A person from the institution and the sponsoring company should be identified to serve in this capacity, establishing a researcher-to-researcher relationship. These are usually the scientists leading the research at both places.

- *Reporting:* Reporting requirements should be limited, and oral reporting allowed as much as possible, to minimize what can otherwise be a time-consuming burden. Sponsors usually require quarterly or semiannual reports or meetings for periodic updates on the research.

- *Publishing rights:* The university should ensure that the laboratory has the right to publish and present all findings. The sponsor may have the right of advance review but not the power to veto proposed publications and not the right of editorial control.
- *Invention rights:* The university owns inventions that arise from the sponsored research but will tell the sponsor about the inventions in confidence.
- *Licensing rights:* The sponsor is usually given a time-limited right to negotiate for an exclusive or nonexclusive license to inventions that arise from the research.
- *Discussion and collaboration:* The university researchers should have the right to discuss their work on the sponsored project with other academic scientists and to collaborate with them (as long as the other scientists are not funded by a different company).

Question: How do I find the right sponsor for my research?

Answer: Look for a strategic as well as a scientific fit, an alignment of business objectives, and a supportive alliance with management. Heed your instincts: If it doesn't feel right, chances are that it's not right.

Consulting Agreements

Faculty members are usually allowed to spend a limited amount of time on consulting outside their institutions. If you have a manual that outlines the university's consulting policies, make sure you read it and understand the policies.

Review the agreement. If your institution chooses to review consulting agreements involving employees, the appropriate office will examine your proposed agreements for conflicts of interest and other problems. If your institution does not review these agreements, consider hiring a qualified person (e.g., a contract law specialist) at your own expense to conduct a contract review because consulting may subject you to personal liability. The TTO can probably give you a referral for this purpose.

Best practices. Consulting agreements vary widely to suit the particulars of a given situation, but they should abide by some general best practices.

Companies should engage consultants for the exchange of ideas only, not to direct or conduct research on behalf of the company. They should not use the name of a consultant or university in promotional materials unless they have written consent.

Consultants should have a limited and reasonable time commitment (e.g., a maximum number of days per year for a specific number of years). There should be a provision allowing the consultant to terminate the agreement by giving reasonable notice, and it is fair for the company to have the same right. Consultants should not disclose information about their laboratory research that they wouldn't normally disclose to members of the scientific community. In addition, they may assign to the company rights in inventions arising from consulting activities if such rights haven't arisen from their own research undertaken as a university employee.

Consulting agreements should acknowledge that the consultant is an employee of the university and is subject to all of its policies, including those related to IP and conflict of interest (COI). If the company requires a noncompetition clause, the consulting agreement should state that this provision doesn't apply to the consultant's relationship with the university.

CONFLICTS OF COMMITMENT AND INTEREST

Whether the lure is simply scientific inquiry or economic rewards, a career can easily run aground on conflict of commitment or interest.

Conflict of Commitment

Is your time really your own? Yes and no. As an employee, your first professional obligation is to fulfill your agreed-upon duties to your employer—the university or research institution. Faculty members should give priority to their time and goals accordingly. The "20 percent rule" is a good guideline: You may take up to 20 percent of your time for outside activities that are in the interest of you and the university.

Conflict of Interest

When dealing with technology transfer, a COI can lurk anywhere from the sponsorship of research to the nature and timing of published research results. One of the most common scenarios for COI is when the content or timing of published research findings affects license income, funding, or stock value for the financial gain of the investigator or the institution. The following definition, from Francis Meyer of A. M. Pappas & Associates, can help you recognize a potential COI:

> A conflict of interest is a situation in which financial or other personal and institutional considerations may directly or significantly affect, or have the appearance of directly and significantly affecting, a faculty or staff member's professional judgment in exercising any university duty or responsibility or in conducting or reporting of research.

Here are some tips to help you avoid COIs:

- Remember that industry is interested in science to increase sales and profits. Altruism and enlightenment are not corporate incentives.
- Be careful about your involvement with start-up companies. With a start-up, you're more likely to have significant equity in the company, and if the company was founded on your technology, the possibility of a COI increases.
- Be careful of what you say during press interviews. It may be better to let the university do the public speaking about your research. Off-the-cuff remarks can present an opportunity for COI to be perceived where none exists, and the perception can be as damaging to a scientist's credibility and career as the reality.

At some point in your research career you may make a discovery in your lab that has potential commercial application. By having a better understanding of the concepts, processes, and potential pitfalls of technology transfer, you will be better prepared to work with your university's TTO and with industry to bring your discovery to market.

RESOURCES

Association of American Medical Colleges. Reports from Task Force on Financial Conflicts of Interest in Clinical Research, *http://www.aamc.org/members/coitf/*.

Association of American Universities. Information on intellectual property issues, *http://www.aau.edu/intellect/ipissues.html*.

Association of University Technology Managers, *http://www.autm.net/index_ie.html*.

Cech, Thomas R., and Joan S. Leonard. "Conflicts of Interest—Moving Beyond Disclosure." *Science* 291(5506):989, 2001.

Council on Governmental Relations. Information on intellectual property, *http://www.cogr.edu/*.

Field, Thomas, G. "Intellectual Property: The Practical and Legal Fundamentals." Franklin Pierce Law Center, *http://www.fplc.edu/tfield/plfip.htm*.

Howard Hughes Medical Institute. "What You Should Know About Intellectual Property, Research Collaborations, Materials Transfers, Consulting, and Confidential Disclosure Agreements," *http://www.hhmi.org/about/ogc/downloads/investigator-guide.pdf*.

Legal Information Institute, Cornell Law School. "Patent Law: An Overview," *http://www.law.cornell.edu/topics/patent.html*.

National Institutes of Health. Information on conflict of interest, *http://grants1.nih.gov/grants/policy/coi/resources.htm*.

Science's Next Wave. Articles on intellectual property and technology transfer, *http://www.nextwave.org*.

U.S. Patent and Trademark Office, *http://www.uspto.gov/*.

Chapter 12

SETTING UP COLLABORATIONS

This chapter is based on the session "Collaborations" that was held at the BWF-HHMI Course in Scientific Management. The session was organized by Victoria McGovern, Ph.D., Burroughs Wellcome Fund, with presentations by Joseph DeRisi, Ph.D., University of California–San Francisco; Claire M. Fraser, Ph.D., The Institute for Genomic Research; and Rick Tarleton, Ph.D., University of Georgia. Additional information was obtained from Tom Misteli, Ph.D., National Cancer Institute, National Institutes of Health, and some of the resources noted in this chapter.

Twenty-first century science is often a collaborative effort. As a beginning investigator, you may want or need to work with scientists in other labs who can offer resources or technical expertise to complement your own. Because a scientific collaboration is a complex exchange, you will need to acquire a new set of managerial and political skills to be a successful collaborator. This chapter summarizes some of the questions you should ask yourself before embarking on a collaborative project and provides some guidelines to help ensure that the project proceeds smoothly.

THE VARIETIES OF COLLABORATION

In science, the word *collaboration* refers to a process during which two or more scientists pool their energies and resources to conduct a research project. In contrast to mentoring—a relationship between a senior and a junior scientist—collaboration is essentially a relationship between equals. Collaborators are researchers who share an interest in the outcome of a project, not buyers or sellers of goods and services. The sharing of reagents or materials described in a publication does not in itself constitute a collaboration; scientists are expected to make published materials available to others. Similarly, a service rendered by a scientist in a core service facility within his or her own institution is usually not considered a collaboration. The core service facility exists to perform specific tasks for other laboratories.

Collaborations can vary greatly in scope, duration, and degree of formality. A limited collaboration might entail only a series of consultations about a technique or the provision of samples to be tested. At the other extreme, several scientists or laboratories might join together to establish a permanent consortium or center for the pursuit of a particular line of research. Depending on its complexity, a collaboration can be launched by an informal agreement that is sealed with a handshake or an e-mail or by a legally binding document.

SHOULD YOU COLLABORATE?

Unless you are in a lab that is exceptionally large, well funded, or very specialized, you will probably need to collaborate at various points in your research. But collaboration is a major responsibility—one that is not to be entered into lightly. It will take time, effort, and the nurturing of relationships. The larger the collaboration, the more complicated it is. Be sure that you are ready to collaborate and that a given opportunity is right for you. Once you've signed on, you will be expected to follow through on your commitments, and your scientific reputation will be at stake.

Assessing a Collaborative Opportunity

Regardless of whether you are approached by another scientist to collaborate or you are thinking of approaching someone to collaborate with you, here are some questions you should ask yourself before embarking on the project:

- Do I need this collaboration in order to move my own work forward? Is there a missing piece—a technique or resource—that I must have?
- Even if collaboration is not strictly necessary to my current work, will it enable me to contribute something significant to science?
- Do I really have the expertise or other resources that are sought by the other collaborator?
- Can this collaboration be conducted efficiently, given such factors as distance, restrictions imposed by my institution, and, in the case of international collaborations, cultural differences or legal and political complications?
- Is there funding for the work envisioned? If not, can it be obtained?
- Can I afford the time? How much will it take away from my other responsibilities? Is the project close enough to my central interests to warrant the necessary time expenditure?
- Is this person someone with whom I want to collaborate? What is his or her track record? Can someone I trust tell me whether this potential collaborator is honest and reliable?
- Are our professional and scientific interests compatible? Does what each of us has to gain or lose by collaborating seem comparable?
- Will this person be accessible to me and consistently interested in the project? (There is no point in collaborating if interaction will be difficult. An investigator at a small lab may be a better match than the director of a large operation because a more established scientist is likely to be busier and less in need of the collaboration.)

Question: If I am not interested in a collaborative project with my department chair or someone else who can influence my tenure appointment, how do I decline politely?

Answer: Explain to your chair that you don't have the resources at the moment to enter a collaborative project or that it would not be beneficial to your grad student, who needs to work on a project that is all his or her own. Offer instead to provide input and suggestions into the research and, if possible, suggest other people with similar expertise who might be good collaborators.

- What exactly is being asked of me? (For example, if someone simply wants your technical expertise or the opportunity to run his or her experiments on your equipment, he or she may not consider you a collaborator at all. The essential ingredient of collaboration is *mutual* interest in the research outcome. If you have this interest, but the other party assumes that you do not, you may not be treated as a collaborator. This may be acceptable, as long as you understand what you are getting into.)
- Can I rule out potential conflicts, either personal or institutional? (For example, you do not want to collaborate with a competitor of your department chair or someone with whom your chair is already collaborating.)
- Before making a decision about a collaboration, consider all factors. A good collaboration can take your research in a completely unexpected course; a bad one will siphon off energy and demoralize you.

SETTING UP A COLLABORATION

Someone may eventually ask you to collaborate, but if you are a beginning investigator, it is more likely that you will need to approach a potential collaborator yourself. A collaboration, like any relationship, has no fixed rules; however, there are some guidelines you can follow to ensure that the collaboration starts off on the right foot and proceeds smoothly (also see box "Personal Qualities of a Good Collaborator," page 178).

Approaching a Potential Collaborator

Once you have identified a potential collaborator and decided that you want to go forward, develop an outline of your proposal for the joint project. Define in detail how you think each of you can complement the other's efforts.

Send an e-mail. Make your initial contact with an inquiry designed to whet the other person's appetite. Send a short e-mail describing your research in general terms and asking for the opportunity for a conversation. Do not call on the telephone first—you do not want to put the person on the spot, and you *do* want to give him or her a chance to find out more about you through personal contacts or your scientific publications.

> *In your initial e-mail, say up front that you are interested in a collaboration. Don't pretend to be asking for expert advice. That can be annoying.*
>
> —Tom Misteli, National Cancer Institute

In your e-mail, focus on the big picture and on conveying your enthusiasm. You must convince your potential collaborator of the following:

- You have the expertise you claim.
- You believe that he or she is the best-possible collaborator for the project at hand.
- Both of you stand to benefit.
- The whole is indeed greater than the sum of the parts.

Be informed. To make your pitch effective, you need to be familiar with your potential collaborator's work. Be sure to read the lab's published papers. You will also need to have a clear idea of what you want to do and of the respective role each of you will play.

Your e-mail should lead to telephone conversations. At this point, a trip to your collaborator's lab for a face-to-face meeting is definitely worthwhile.

The Collaboration Agreement

Using an informal agreement. An exchange of e-mails is usually sufficient to get a project under way. Before you actually start the work, however, it's best to develop and agree on a detailed written summary of your joint research plan. The plan should spell out the following:

- The purpose of the collaboration
- The scope of work
- The expected contribution of each collaborator
- Financial responsibilities of each collaborator
- Milestones
- Reporting obligations
- Expectations about authorship

An explicit plan offers several advantages. It prevents misunderstandings, and it helps keep the project on track. Furthermore, if you expect to apply for funding for the project, this information can function as a grant proposal. In collaborations between two academic labs, the collaboration agreement can simply be e-mailed back and forth until both parties are satisfied; obtaining signatures could seem overly formal.

Using a formal agreement. A formal, legally binding written agreement is probably necessary if the collaboration involves a commercial entity such as a pharmaceutical company or a commercial application in which a patent is an expected outcome. You and your collaborator will want to consult with appropriate offices at your respective institutions to help you draft this agreement. This will typically be the technology transfer office or the grants and contracts office; their staff may also arrange for legal review by the institution's attorneys. Make sure to spell out the time period of the collaboration or provide a mechanism by which you can terminate your involvement.

Be aware that if your academic collaborator has financial support from a company for his or her share of the work, the funding agreement may contain restrictions that apply to the collaborative project. For example, the company may have the right to delay publication and to license the results of the collaboration. If the collaboration is an important one for your laboratory, be sure to ask in advance whether your collaborator will use company funding for his or her work on your joint project. If so, you can ask your institution's technology transfer office to help you determine whether there are restrictions that apply to your share of the work. It may be possible to negotiate an agreement that limits the effect your collaborator's funding arrangements have on you. (See chapter 11, "Understanding Technology Transfer," for more information about company-sponsored research.)

THE INGREDIENTS OF A SUCCESSFUL COLLABORATION

Once your agreement is in place and your expectations of one another are clear, you and your collaborator can focus on keeping your lines of communication open and maintaining attitudes of mutual consideration and respect.

Keeping the Lines of Communication Open

An open, trusting relationship is essential if you want to be able to discuss problems candidly and to give and receive critical feedback. In a good collaboration, participants stay in close touch and are accessible to one another. Make it a practice to return your collaborator's calls right away.

Meetings. Set up systems to ensure that regular communication takes place. A fixed schedule of face-to-face meetings or conference calls is a must. Also consider setting up occasional videoconferences if your institution and your collaborator's have such facilities. No matter what type of meeting you choose, send out agendas by e-mail, take notes during the discussions, and send out e-mail summaries of the meetings. Include in the summaries "action items" for each collaborator.

Keeping up. Once the project is under way, stay with it. Do not be the "rate-limiting step" that holds things up. When unavoidable conflicts emerge and you can't meet a deadline, let that fact be known right away, so that the deadline can be reset.

Dealing with Authorship and Intellectual Property Issues

Expectations for authorship. Because credit for your work, expressed as authorship of publications, is crucial to your scientific career, you need to pay attention to how credit will be distributed in a collaboration. It's best to discuss expectations for authorship, including who will be first author, before a collaboration begins. However, agree to revisit the issue as publication nears; the relative contributions of different participants often changes from what was originally envisioned. Once you have a sense of whether the data from your experiments can be published, discuss plans for publication immediately; don't wait until a manuscript draft is prepared.

Personal Qualities of a Good Collaborator

Honesty

- Disclose anything that might affect someone's decision to collaborate.
- Once the collaboration is under way, be willing to "cut through the nonsense" and offer constructive criticism.

Openness

- Stay in touch with your collaborator throughout the project, especially when there are problems or delays.
- Try to resolve problems with your collaborator directly.

Fairness

- Be sure to give credit where it is due.

Industry

- Put your full effort into the project.
- Carry your fair share of the labor and financial outlays.

Respect

- Appreciate your collaborator's contributions.
- Never assume that your contributions are more important than those of your collaborator.

Reliability

- Deliver what you have promised, on time.

Pursuing patents. If patents are sought, applications should be filed before the work is presented publicly or is published; otherwise, rights will be lost. Do not jeopardize your own or the other party's intellectual property rights by disclosing your results prematurely.

If your collaboration produces patentable discoveries, you will undoubtedly need to deal with the legal concept of "joint intellectual property." Generally, you will have to assign your ownership in intellectual property to your institution or employer, and your collaborator must do the same to his or her institution. Each party to a collaboration will retain its own "background" intellectual property, that is, the intellectual property it owned before undertaking the project. Each party will also retain the intellectual property rights to discoveries created solely by its own researchers in the course of the project. Joint intellectual property is that created jointly by collaborating researchers. The collaborators' institutions may file a joint patent application that names inventors from both institutions, and the institutions will hold the patent jointly. Often, the institutions will need to reach an agreement on management and licensing of the intellectual property so that any royalties can be shared according to an agreed-upon formula.

If you think a joint patent application is a likely outcome of your collaboration, ask yourself these questions before you begin the collaboration:

- What aspects of the proposed project are so interactive that any potential discoveries will be owned jointly?
- Who will take responsibility for, and incur the expense of, filing joint patent applications?
- Who will maintain the patents once received?

See chapter 11, "Understanding Technology Transfer," for more information about the patent process, including the effect disclosures can have on the ability to obtain patent rights.

SPECIAL CHALLENGES FOR THE BEGINNING INVESTIGATOR

In the early stages of your career, collaboration can present particular challenges. You are under pressure to get your own research program up and running. You can't afford to let your progress toward tenure be impeded by collaborations that do not yield good results and appropriate credit. You need to keep the following facts of scientific life firmly in mind as you decide about specific collaborations:

- If you collaborate with established, well-known scientists, your tenure committee may undervalue your role in the effort. People may assume that you played a minor role, even if you are first author on a paper. For the same reason, collaborating with your postdoctoral mentor may not enhance your reputation as an independent investigator. If you do collaborate with established scientists or your previous mentor, make sure you arrange the collaboration so that the relative contributions of each scientist are made clear in publications and other communications.
- The larger the collaborator's lab and the more complex the collaboration, the harder it will be to negotiate first or last authorship. Smaller projects may offer a better chance of getting credit.
- If you have special technical expertise that is in demand, you may be inundated by numerous requests to collaborate, even within your own department. Do not allow your time to become so fragmented that your central research projects are neglected. Learn to say no gracefully and, if needed, ask your department chair to offer some protection.
- If you engage in multiple collaborations, the probability increases that you will find yourself with a conflict of interest. Especially in these early years, it is better to keep things simple so that you know all the actors and can identify potential conflicts.

When Your Students and Postdocs Collaborate

Your graduate students and postdocs need to learn to collaborate. You can start them off by assigning them joint projects and by guiding them in establishing their expectations of each other and in monitoring the fulfillment of promises.

It is quite another matter when your students and postdocs approach scientists outside your lab or are themselves approached as potential collaborators. They may have no idea of the politics involved or of the extent of the commitments they are making. Insist on your prerogative to approve all outside commitments in advance.

SPECIAL CHALLENGES OF INTERNATIONAL COLLABORATION

The practical difficulties of international collaboration can be overwhelming. They include geographic distance, as well as cultural, linguistic, and political barriers. You must be realistic in judging whether you have the energy and resources to make a long-distance project worthwhile. Ask yourself these questions:

- How much travel will be required? What will be the costs of each trip in terms of airfare, hotel accommodations, and time away from the lab?
- Is travel to this country safe?
- How good are the channels of long-distance communication? (E-mail is virtually universal and certainly will help, but if the other lab is on the other side of the world, long-distance telephone conversations will be inconvenient because of the time difference.)
- Do I understand the other culture—especially its etiquette of information sharing—well enough to communicate about scientific matters?
- Do I know the language of my potential collaborators? Do they have a good command of oral and written English? Will scientific papers be published in another language? If so, how can I vouch for the translation?
- What are the country's customs regarding publishing and authorship?
- Is the other lab adequately equipped and supported by the country's infrastructure (e.g., electricity, telecommunications)?

A Funding Source for International Collaborations

The Human Frontier Science Program brings together scientists from different countries for collaborations focused on the complex mechanisms of living organisms. The three-year Young Investigators' Grants provide $250,000 per year for a team of researchers, all of whom are within the first five years of establishing an independent laboratory. See *http://www.hfsp.org*.

Although physical and technical factors are important, it is the human dimension that most often makes or breaks an international collaboration. Be especially sensitive to emotions that may be in play under the surface, especially if your collaborator's lab is less well funded than your own. For example, your collaborators may have concerns about being exploited or disparaged.

Considering these special challenges, international collaboration requires extra dedication. Two key ingredients should be in place at the outset: a stable funding source and at least one individual in the other lab who is as committed to the project as you are.

WHEN A COLLABORATION IS NOT WORKING

Collaborations can fail for various reasons. Here are some possible scenarios:

- One party loses interest or develops other priorities and intentionally or inadvertently puts the project on the back burner. There's no intent to renege, but deadlines are allowed to slip.
- Illness or family problems hinder someone's progress.
- Scientific results are not forthcoming, and the project simply stalls.
- Honest disagreements arise about the plan, finances, or authorship.
- One or both parties behave badly (e.g., they do not honor some aspect of the agreement, steal credit, or disparage the other collaborator to others).

When such situations arise, you will have to decide how to protect yourself. The worst thing you can do is to allow a bad situation to fester. If you decide your colleague is failing to fulfill the original agreements, get on the phone, or on a plane if need be, and have a straightforward discussion. It is worth your while to try to fix a situation, especially if you have invested significant time and resources in the project. If, however, the other party has lost all interest or you really don't get along, the best thing might be to back out. Although you may be tempted to let your colleagues know about the failure, remember that such a retaliation can harm your reputation as much as that of your collaborator.

If a collaboration doesn't succeed, it's important not to become discouraged. Although collaborations can be a lot of work and, at times, challenging, you will gain much from working with other scientists. Your research can take unexpected turns and expand into new and exciting areas. You will form professional relationships with scientists outside your department who may be willing to write letters of recom-mendation when it is time to apply for tenure. Your collaborators can help increase your visibility by inviting you to give seminars at their institutes, and they might send graduate students or postdocs to work in your lab.

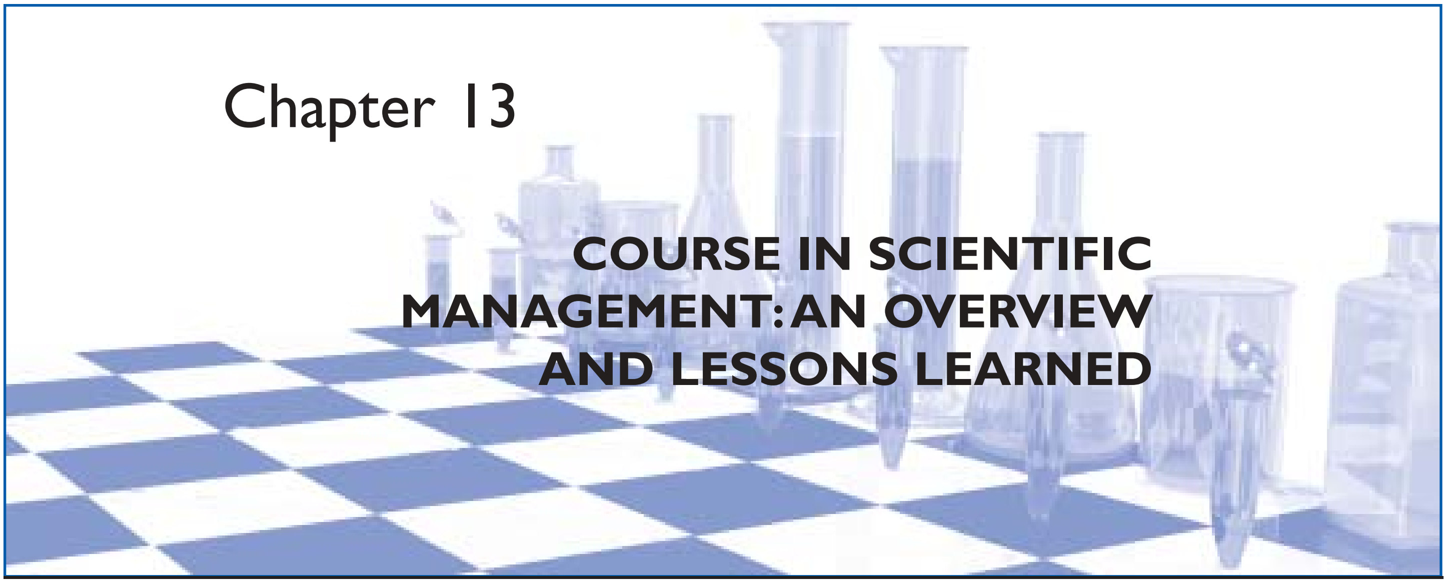
RESOURCES

Adams, Michael J. "Mutual Benefit: Building a Successful Collaboration." *Science*'s Next Wave (October 6, 2000), *http://nextwave.sciencemag.org/cgi/content/full/2000/10/04/5*.

Dee, Phil. "Yours Transferably: Going Global 2—Making Contact." *Science*'s Next Wave (February 16, 2001), *http://nextwave.sciencemag.org/cgi/content/full/2001/02/14/3?*.

De Pass, Anthony. "Collaborations: Critical to Research Success at Minority Institutions." *Science*'s Next Wave (March 2, 2001), *http://nextwave.sciencemag.org/cgi/content/full/2001/02/28/19?*.

budget
publications



Chapter 13

COURSE IN SCIENTIFIC MANAGEMENT: AN OVERVIEW AND LESSONS LEARNED

Course codirectors and codevelopers: Maryrose E. Franko (HHMI) and Martin Ionescu-Pioggia (BWF)

Session organizers: Jim Austin (AAAS), Maryrose E. Franko (HHMI), Martin Ionescu-Pioggia (BWF), Victoria McGovern (BWF), Rolly L. Simpson (BWF), and Andrea L. Stith (HHMI; now at the Federation of American Societies for Experimental Biology)

Course coordinator: Laura Bonetta, science writer and consultant

From July 27 to July 31, 2002, the Burroughs Wellcome Fund (BWF) and the Howard Hughes Medical Institute (HHMI) sponsored the "Course in Scientific Management for the Beginning Academic Investigator." It was held at HHMI headquarters in Chevy Chase, Maryland. The 128 participants were biomedical research scientists who had recently received their first academic appointment or postdoctoral fellows looking for an appointment; all were current or former BWF and HHMI grantees. This chapter explains why and how the course was developed, gives an overview of the course sessions and the materials provided to course participants, and discusses the course evaluation and lessons learned.

COURSE DEVELOPMENT

Why Have a Course in Scientific Management?

The course was conceived following discussions between BWF and HHMI staff and scientists who had received research training or career development grants from the two organizations and expressed a need for additional training in laboratory management to successfully launch their research programs. These scientists had not received formal training in this area during graduate or medical school or postdoctoral study.

The course had three goals. First, it aimed to provide participants with laboratory management skills that would help them rapidly establish well-run, productive laboratories. Second, it aimed to provide participants with an opportunity to develop networks with their peers and more established scientists. Third, it sought to point out the need for early career training in laboratory management to universities, professional societies, and postdoctoral associations and provide these institutions with an example of how they might design their own courses in laboratory management.

How the Course Took Shape

The course was developed over a two-and-a-half year period by staff from BWF and HHMI, with assistance from the American Association for the Advancement of Science (AAAS).

The first year was spent identifying the topics to be covered. The course developers convened two focus groups mainly composed of BWF and HHMI grant recipients, including advanced postdocs and newly appointed faculty and physician and non-physician scientists. The focus group participants (see Appendix 1) identified a diverse range of career development needs that coalesced under the general theme of scientific management. To further refine the list of topics, the course developers consulted with senior scientists and professionals affiliated with BWF and HHMI.

The course developers also retained executive coaches Christine Harris, Ed.D., and Joan C. King, Ph.D., to create an in-depth introductory session on laboratory leadership and interpersonal management strategies designed specifically for scientists in laboratory settings. As part of a preliminary needs assessment, Dr. Harris and Dr. King designed a questionnaire that was completed by 41 "model laboratory leaders"—biomedical research scientists who had been identified by their peers, students, and postdocs as particularly good motivators, mentors, leaders, or managers (see Appendix 2 for the list of model laboratory leaders).

Because of the limited time frame of the course, certain important topics were not covered, such as lab safety. Course developers and focus group participants felt that this information was either taught at most universities or was available from other sources.

The course developers eventually narrowed down the list of potential topics to 14, which they thought could be adequately covered within the time frame of the course. These topics were

- Laboratory leadership
- Project management
- Collaborations
- The scientific investigator within the university structure
- Getting funded
- Getting published
- Current issues in research ethics
- Time management
- Data management and laboratory notebooks
- Mentoring and being mentored
- Gender issues in the laboratory
- Technology transfer
- Obtaining and negotiating a faculty position
- Budgets and budgeting

The next step was to develop the chosen topics into sessions. The session organizers researched the areas, discussed the topics with BWF and HHMI grantees and senior scientific staff, determined the amount of time needed to address each topic and the format to be used, identified and contacted potential speakers, and organized the background materials for the course syllabus. A course coordinator oversaw the session organizers' activities, set the final course agenda, sent out invitations to speakers and participants, and tracked the responses. The preparation time for materials, speaker invitations, presentations, and the course notebook (see "Course Materials" below) was about 10 months.

Course Agenda and Session Formats

The course began with an evening reception and welcome and keynote addresses by the presidents of BWF and HHMI and continued over the next three-and-a-half days, with a full schedule of back-to-back sessions (see Appendix 3 for the course schedule). Course topics were presented in four formats: workshop (one session), panel discussion (seven sessions), roundtable discussion (one session), and single speaker or keynote address (seven sessions). Some sessions of interest to particular subgroups of participants (e.g., technology transfer and obtaining a faculty position) were offered concurrently. Each session concluded with time for questions and answers. The course format also included opportunities for participants to informally network with their peers, the speakers, and senior scientists and staff from BWF and HHMI.

Speakers and Participants

The course was taught by 32 scientists and other professionals from academia, industry, and scientific communications (see Appendix 4).

The number of participants was limited to 128 current and former BWF and HHMI grant recipients, who were selected on the basis of the stage they had reached in their scientific careers. Preference was given to scientists who either had recently obtained academic faculty positions and started their laboratories, had received a job offer, or had started interviewing for a position. Forty-one percent of the course participants were women, 43 percent were physician-scientists, and 48 percent were advanced postdocs.

Cost per Participant

The actual cost per participant is difficult to calculate because HHMI lent much of its infrastructure to the course and most development costs were included in staff salaries or in time donated by speakers. However, not counting these costs, the amount was approximately $2,800 per participant, which was paid for by the sponsors. Most of this amount can be attributed to travel, meals, lodging for participants and speakers and speaker honoraria. A similar course conducted for on-site participants at a university would cost significantly less.

Course Materials

Each participant was given a course notebook—a large three-ring binder containing the agenda, outlines of the presentations, and other resource materials. It also contained exercises that were to be completed during or after some of the sessions. Each participant was also given a copy of HHMI-produced videos on laboratory safety and the opportunity to receive complimentary copies of the following books:

- *At the Helm: A Laboratory Navigator*, by Kathy Barker (Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press, 2002)

- *Tomorrow's Professor: Preparing for an Academic Career in Science Engineering*, by Richard M. Reis (New York: IEEE Press, 1997)
- *Writing the Laboratory Notebook*, by Howard Kanare (Washington, DC: American Chemical Society, 1985)
- *Project Management for Dummies*, by Stanley E. Portny (New York: Hungry Minds, 2001)

SYNOPSIS OF SESSIONS

This section provides an overview of the course sessions in the approximate order in which they took place, along with the session learning objectives and highlights from the session evaluations.

Starting a Research Group in 1978: Are Any of the Lessons Still Relevant in 2002?

Following a welcome address by BWF President Enriqueta C. Bond, Ph.D., HHMI President and Nobel laureate Thomas R. Cech, Ph.D., described his entry into biomedical science in the 1970s. Dr. Cech talked about the challenge of job hunting and negotiating for resources; the strategies he used to balance teaching, research, and other responsibilities; and the lessons he learned about the importance of interpersonal skills in the establishment of a successful research program.

Excerpts from Dr. Cech's address can be found in chapter 3, "Defining and Implementing Your Mission," and at *http://www.hhmi.org/labmanagement*.

Workshop in Basic Laboratory Leadership Skills

This eight-and-a-half-hour workshop, held over two consecutive days, was organized by Martin Ionescu-Pioggia, Ph.D. (BWF). Interpersonal skills are among the most difficult to teach effectively and the most important in managing a laboratory. Consequently, the course organizers allotted the largest amount of time to this session. The executive coaches for the session, management consultant Christine Harris, Ed.D., and scientist Joan C. King, Ph.D., taught participants the skills that form the basis for effective leadership in the scientific setting. Based on the results of their survey with 41 model lab leaders and six in-depth interviews, together with their combined expertise and experience, Dr. Harris and Dr. King recommended a set of topics to be included in the leadership portion of the course. These topics included creating a vision and mission statement for the laboratory; identifying key leadership values; and learning how to lead and manage, interact with, and motivate laboratory staff. Extensive time was devoted to understanding and appreciating the variety of interpersonal preferences and helping participants identify their communication styles and personality types. The workshop provided participants with opportunities for practicing lab leadership skills through visualization and role-playing exercises and small-group discussions. For example, participants were asked to visualize the ideal laboratory, identify their values, and translate their visions and values into an action plan. Participants worked on strategies for communicating expectations, giving and receiving feedback, and managing conflict. They also took the Myers-Briggs Type Indicator, the widely used personality inventory developed by Isabel Briggs Myers and Katharine C. Briggs.

Because only basic leadership and interpersonal skills could be taught during the course, the organizers arranged for participants to obtain additional one-on-one tutorials after the course to develop leadership skills of particular relevance to the issues in their laboratories. Participants were invited to apply for six hours of post-course coaching in laboratory leadership from Dr. Harris and Dr. King.

Project Management

This two-and-a-half-hour session was organized by Jim Austin, Ph.D. (AAAS). Stanley E. Portny (Stanley E. Portny and Associates) spoke about developing a managerial perspective toward the operation of a laboratory. A successful research program comprises a series of discrete projects, all designed to help address different aspects of the overall program's goals. This session presented a proactive approach to planning and performing these projects that minimizes wasted time and effort, helps anticipate risks and uncertainties, and supports timely and insightful project tracking and control. The format consisted of a two-hour presentation followed by a question-and-answer period.

Collaborations

This one-and-a-half-hour panel session was organized by Victoria McGovern, Ph.D. (BWF). The panelists were Claire M. Fraser, Ph.D. (The Institute for Genomic Research); Rick Tarleton, Ph.D. (University of Georgia); and Joseph DeRisi, Ph.D. (University of California–San Francisco). It explored the benefits and challenges of collaborative research as well as the practical issues of establishing collaborations across sectors and among researchers in disparate fields. The format consisted of a 10-minute presentation by each panelist, followed by a question-and-answer period.

The Scientific Investigator Within the University Structure

This evening keynote session was organized by Maryrose E. Franko, Ph.D. (HHMI). Tony G. Waldrop, Ph.D. (University of North Carolina–Chapel Hill), gave an overview of the "standard" organizational structure of a university, how the investigator fits within this structure, and the entities the investigator interacts with. He also described the factors involved in promotion and tenure for university faculty.

Getting Funded

This two-hour panel discussion was organized by Jim Austin, Ph.D. (AAAS). The panelists were Anthony M. Coelho Jr., Ph.D. (Office of the Director, National Institutes of Health [NIH]); Bettie J. Graham, Ph.D. (National Human Genome Research Institute, NIH); and Suzanne Pfeffer, Ph.D. (Stanford University). The focus of this session was on preparing winning proposals in a competitive environment. Key themes included understanding the mission of the grant-making organization; the intricacies of the review process at NIH; and how best to meet the expectations of review panel members. The format consisted of a 10-minute presentation by each panelist, followed by a question-and-answer period.

Getting Published

This one-hour session was organized by Jim Austin, Ph.D. (AAAS). Angela Eggleston, Ph.D. (senior editor, *Cell, Molecular Cell*, and *Developmental Cell*), gave participants an overview of the submission and review process at a scientific journal, including how the initial assessment of a submission is made, how reviewers are chosen, how the decision to publish is made, and what the process for revisions and appeals is. The presentation also provided tips on developing a paper, including what to include in a cover letter, abstract, and introduction; how to present results; and how to apply those results more broadly in the discussion. The format consisted of a 45-minute presentation followed by a question-and-answer period.

Current Issues in Research Ethics

This evening keynote session was organized by Maryrose E. Franko, Ph.D. (HHMI). R. Alta Charo, J.D. (University of Wisconsin Law School), talked about the challenges of protecting the rights and welfare of all who volunteer to participate in research and to make those protections relevant to the myriad new forms of research. Topics included the examination of medical records, stored human tissue samples, family cohorts, and international collaborative studies. Dr. Charo also spoke about the challenge of developing better rules to protect those who cannot decide for themselves to participate, such as children, the mentally ill, or the neurologically impaired, as well as the challenge of managing conflict of interest within review boards.

Excerpts from Dr. Charo's presentation can be found at *http://www.hhmi.org/labmanagement*.

Time Management

This two-hour panel session was organized by Maryrose E. Franko, Ph.D. (HHMI). The panelists were Richard M. Reis, Ph.D. (Stanford University); Sandra L. Schmid, Ph.D. (Scripps Research Institute); and Todd R. Golub, M.D. (Dana-Farber Cancer Institute; also HHMI associate investigator). The session focused on two distinct aspects of time management in a laboratory setting: managing day-to-day activities efficiently, such as handling multiple priorities and deadlines, and managing the concurrent demands of teaching, administrative duties, and family responsibilities. The format consisted of a 15-minute presentation by each panelist, followed by a question-and-answer period.

Data Management and Laboratory Notebooks

This two-hour panel session was organized by Maryrose E. Franko, Ph.D. (HHMI). The panelists were Howard Kanare, Ph.D. (Construction Technology Laboratories); Joseph M. Vinetz, M.D. (University of Texas Medical Branch–Galveston); and David J. Adams, Ph.D. (Duke University Medical Center). The session focused on how to set up a system for efficient flow of information in the lab and how to maintain accurate and consistent records. Case studies were presented to stress the importance of maintaining electronic records and laboratory notebooks. The format consisted of a 15-minute presentation by each panelist, followed by a question-and-answer period.

Mentoring and Being Mentored

This topic was addressed in two separate sessions, which were organized by Victoria McGovern, Ph.D. (BWF). Speakers for the first session were Dorothy E. Shippen, Ph.D. (Texas A&M University); David S. Roos, Ph.D. (University of Pennsylvania); and Stephen L. Hajduk, Ph.D. (University of Alabama–Birmingham; now at the Marine Biological Laboratory). Panelists for the second session were E. Lynn Zechiedrich, Ph.D. (Baylor College of Medicine), and Elizabeth Keath, Ph.D. (Saint Louis University).

The sessions explored what it means to be a mentor and, in particular, using mentoring as a strategy for facilitating learning. The first session, lasting one-and-a-half hours, was an introduction to basic principles of mentoring. The presentations were followed by a 30-minute question-and-answer period. Participants were given "homework" questions to complete in preparation for a one-hour session the next day that included a panel discussion and a question-and-answer session in response to questions from the audience. The second session on mentoring was held concurrently with the session "Budgets and Budgeting."

Roundtable Discussion: Problems and Solutions in Scientific Management

This two-hour panel session was organized by Rolly L. Simpson (BWF); Laura Bonetta, Ph.D. (course coordinator); and Maryrose E. Franko, Ph.D. (HHMI). The moderators were Maryrose E. Franko and Rolly L. Simpson. The panelists were Thomas R. Cech, Ph.D. (HHMI); Peter J. Bruns, Ph.D. (HHMI); Klaus R. L. Nüsslein, Ph.D. (University of Massachusetts–Amherst); Christine Harris, Ed.D. (laboratory leadership skills workshop designer); and Kathy Barker, Ph.D. (author, *At the Helm: A Laboratory Navigator*).

Before the course, participants were asked to submit summaries of problems they had encountered in their labs. Forty responses were received, the majority dealing with issues in laboratory leadership and mentoring. BWF and HHMI staff then selected 10 cases that were representative of the topics covered in the course and career situations of course participants. Participants met in the conference center auditorium for an introduction to the session. Then participants were assigned to 1 of 10 small groups, each consisting of about 13 participants. Each group was given a case study and 30 minutes to discuss the problem and develop a solution. The groups then returned to the auditorium, and each was given 8 minutes to present its solution to all the session participants and receive feedback from a panel that included course presenters and BWF and HHMI staff who had developed the course sessions.

The session was included as a way to tie together all the issues discussed during the course and to provide participants with an opportunity to use what they had learned in the course to develop solutions to lab management problems. The most common themes selected for the case studies were mentoring, collaboration, and laboratory leadership. In order to cover as many areas as possible, issues involving publishing, technology transfer, time management, and project management were also included. The following laboratory management problems were discussed:

- Collaborations. A senior principal investigator used a tool for genetic mapping studies that was developed by an assistant professor working in the field of bioinformatics. The assistant professor's technician trained the senior principal investigator's technician in the use of the tool. Should the assistant professor's contribution be acknowledged in a subsequent paper?
- Mentoring and time management. A fourth-year postdoctoral fellow in a large research lab in a large medical school is performing poorly because of family obligations and the lack of a long-term goal. What would be the best advice from the postdoc's mentor?

- Mentoring, laboratory leadership, and time management. A first-year clinical faculty member in a university research laboratory has accepted a position that includes clinical responsibilities and protected time for research. How can the physician-scientist balance laboratory with clinical responsibilities?

- Mentoring and technology transfer. A postdoctoral fellow in the last year of training (Ph.D.) in a university research laboratory was working in an area that was no longer being pursued by the principal investigator. However, as results were accumulated, the principal investigator developed renewed interest in the area. The postdoc wants to continue the work as an independent investigator after leaving the lab, but the principal investigator wants to keep the project. How can this situation be resolved?

- Mentoring and laboratory leadership. A new assistant professor wants his three postdocs to be more motivated and productive. How can this be done?

- Project management and laboratory leadership. A postdoc joins two other postdocs on a project that requires two of them to work all day on Sundays. The postdoc who most recently joined the group finds it increasingly difficult to work on Sundays because of family responsibilities. Can a compromise be worked out?

- Mentoring. A doctoral student left a lab to take a postdoctoral position before a manuscript was completed. Subsequently, some experiments were repeated and new data were incorporated with the understanding that the former doctoral student would still be an author on the paper. After three years, the manuscript is still not complete. What can the former doctoral student do to move the manuscript along? What responsibility does a principal investigator have to former students?

- Laboratory leadership. A lab technician was a productive member of a laboratory until his acceptance into an MBA program, at which time his work and attitude began to deteriorate. It will be nine months before the lab tech starts school. What can the principal investigator do to improve the lab tech's performance?

- University structure. Two faculty members, both Ph.D.s, were encouraged to take leading roles in the establishment of a translational research program. Because of conflict between the two faculty members, the program has gone nowhere. What can be done to correct this situation?

- Mentoring. A physician-scientist will be leaving a lab to take a position as an independent investigator. The physician-scientist has been working on several projects using mouse knockout strains and would like to take one of the projects to the new position. The principal investigator is reluctant. What is the principal investigator's responsibility?

Gender Issues in the Laboratory

This evening keynote session was organized by Laura Bonetta, Ph.D. (course coordinator). Gina Turrigiano, Ph.D. (Brandeis University), discussed how gender plays a role in the professional life of a research scientist. She reviewed data from a study on the status of women faculty in science at the Massachusetts Institute of Technology that indicated inequities in advancement and salary levels and found that women faculty felt more marginalized as their careers progressed. Dr. Turrigiano also spoke about the challenges of balancing work and family and related issues, such as deciding when to have children and taking maternity leave. She discussed the special issues that principal investigators face as they mentor women and that female scientists face as they seek to be mentored.

Technology Transfer

This two-hour panel session was organized by Andrea L. Stith, Ph.D. (HHMI; now at the Federation of American Societies for Experimental Biology). The panelists were Francis J. Meyer, Ph.D. (A. M. Pappas & Associates); Christopher T. Moulding (HHMI); and Martha J. Connolly, Ph.D. (EntreMed; now at the Maryland Technology Enterprise Institute). This session introduced participants to the terminology, processes, and concepts related to intellectual property and technology transfer. The speakers demonstrated various scenarios to help participants avoid potential disputes and hazards and maximize their effectiveness in working within the system. Participants received a list of helpful Web sites, textbooks, and journal articles. The format consisted of three 25-minute lectures followed by a 30-minute question-and-answer period. The session was held concurrently with the session "Obtaining and Negotiating a Faculty Position."

Obtaining and Negotiating a Faculty Position

This two-hour panel session was organized by Rolly L. Simpson (BWF). The speakers were Chris M. Golde, Ph.D. (Carnegie Foundation for the Advancement of Teaching); Johannes Walter, Ph.D. (Harvard Medical School); and Christopher Wylie, Ph.D. (Cincinnati Children's Hospital Research Foundation). It was included in the course because the topic was of key interest to advanced postdoctoral participants who participated in the precourse focus groups. The format consisted of three 25-minute lectures followed by a 30-minute question-and-answer period.

Budgets and Budgeting

This one-hour session was organized by Jim Austin, Ph.D. (AAAS). Michael E. McClure (National Institute of Environmental Health Sciences, NIH) discussed writing effective grant proposals and tracking and managing the fiscal side of conducting research. The format consisted of a half-hour presentation followed by a question-and-answer period. The session was held concurrently with the "Mentoring Panel Discussion."

COURSE EVALUATION AND LESSONS LEARNED

Evaluation Process

Participants completed an evaluation at the end of each session and an overall evaluation at the end of the course (see Appendix 5 for a sample session evaluation form and Appendix 6 for the course summary evaluation form). The evaluations were anonymous—responses were associated with the participant's badge number on the evaluation form. The number was then linked to the participant's demographic information (e.g., academic level, degree), but not to his or her name. Additional feedback was obtained from a focus group held with several course participants directly after the course ended. Evaluations at six months and at one year have been conducted to determine which components of the course have been useful to participants.

Information from the on-site evaluation and the postcourse focus group was analyzed by an evaluation specialist. The results were used to shape the content of this manual and may prove useful to institutions that are developing their own courses in scientific management. A summary of the evaluation results is presented below. For detailed information about evaluation outcomes, contact BWF and HHMI at *labmgmt@hhmi.org*.

Lessons Learned

Overall impressions of the course. All 128 course participants completed the course evaluation and said they would enthusiastically recommend the course to their colleagues. Seventy-eight percent rated the course as far exceeding or exceeding their expectations for overall course quality, and 87 percent rated the course as far exceeding or exceeding their expectations for overall relevance. Eighty-one percent said the degree of change they anticipated in the way they run or will run their laboratories far exceeded or exceeded their precourse expectations. Many mentioned they planned to share information from the course with coworkers. Some pointed out that the course was especially valuable for postdocs who had yet to set up a laboratory. Some participants thought the course was valuable both to senior postdocs and junior faculty and that it was good to have a mix of people at different levels to get different perspectives.

Participants were asked to rate the overall value of each session. The following six sessions (in alphabetical order) received the highest ratings:

- "Getting Funded"
- "Mentoring and Being Mentored"
- "Obtaining and Negotiating a Faculty Position"
- "Roundtable Discussion of Problems in Scientific Management"
- "Time Management"
- "Workshop in Basic Laboratory Leadership Skills"

Format of the course. Many participants liked that the course was held as a "retreat" rather than at a university or some other setting where it would be more difficult to focus on the course content and take advantage of the networking opportunities. One individual pointed out that he/she would not have been comfortable discussing a laboratory management problem if the course had been offered at his/her university because of the lack of anonymity in such a setting.

Some participants thought that the course would be improved by providing more take-home materials in book, CD/DVD, or Web format. Several participants felt one way to increase exposure to the course was to offer video conferencing with small groups interacting at local sites. All seemed to agree that the information provided in the course should be disseminated as widely as possible.

Improving the course. Participants had the following suggestions:

- Increase the input from senior investigators—for example, include them in the roundtable discussion breakout groups and have them sit on more panels and participate in the question-and-answer periods at the end of the sessions.

- Include at least one practicing scientist in each panel session.
- Have panelists review each other's presentations before the course and adapt their presentations to avoid overlap. Allow more time for questions and answers in each session, and have a strong moderator to keep the questions focused on the session topic.
- Reduce the number of plenary lectures and increase the number of small-group discussions.
- Use "graduates" of the course to lead small-group breakout sessions in future courses.
- Focus less on "big picture" aspects of a topic and more on its relation to scientific management and the needs of a beginning investigator.
- Have the speakers include a short executive summary or take-home message for their sessions.
- Promote networking among course participants and with speakers and senior investigators by setting aside more time for informal interactions and organizing the tables by scientific field at one of the dinners.
- Offer a follow-up workshop for more established principal investigators who are getting ready to apply for tenure.

Overall course length. Seventy-four percent felt the length was about right. Twenty-four percent felt that the course was too long and should be reduced by half to one day. Participants felt that time could be saved by

- Holding the speakers to their allotted time
- Keeping the question-and-answer sessions more focused
- Offering more simultaneous sessions (however, some participants felt that they were missing something when sessions were offered concurrently)
- Reducing the length of the "Workshop in Basic Laboratory Leadership Skills" by conducting the Myers-Briggs testing before the course
- Giving participants any session-related "homework" materials before the course

Several criticized the 7:30 a.m. start times, especially those who had arrived from the West Coast. Several said they would have appreciated a longer break in the afternoon, with sufficient time for exercise or rest, even knowing that this would then push the course sessions into the evening hours.

Most useful aspects of the course. Many respondents commented that one of the most valuable parts of the course was the question-and-answer period at the end of each session. This part of the session was sometimes considered more valuable than the structured presentations. Many respondents also felt that the networking opportunities during the breaks and meals were very important and would like to have had even more such opportunities (possibly including a more purely social event). The most popular format for the sessions was the small breakout group. Many participants also noted that the most useful panels included background information provided by the presenters, followed by case study examples. Having a diverse panel in terms of age, faculty position, and scientific discipline was also thought to be useful.

Sessions identified as having overlap. The following sessions were identified as having similar material: "Getting Funded" and "Budgets and Budgeting," "Gender Issues" and "Time Management," and "Project Management" and "Time Management." Several respondents commented that they didn't think the sessions were redundant so much as that some information was presented in more than one session. Some thought that in many cases this overlap served to reinforce the concepts.

The course organizers held one or more group conferences with members of each session before the course, partially to reduce overlap, which is difficult to accomplish when multiple independent presenters are used for different sessions. These conferences were successful in reducing overlap within a session and probably reduced overlap throughout the course.

Additional topics for future courses. Many suggestions for additional topics were offered, but there was also concern about lengthening the course to include such sessions. The following is a list of ideas contributed by respondents, in no particular order of popularity:

- Include a separate session for physician-scientists.
- Include a session on designing and conducting an academic course. (It was thought that this could be offered simultaneously with the session for physician-scientists.)
- Provide more specific information on mentoring women and minorities in science.
- Include a discussion of issues related to hiring and firing.
- Include a separate session on how to get tenure, instead of combining the topic with how to negotiate for and obtain a job.

Lessons Learned by Session

Workshop in Basic Laboratory Leadership Skills. This session worked especially well when the participants broke into small groups to discuss how to resolve problems or conflicts. It was suggested that sending reading material to the participants before the beginning of the course might be a way to reduce the time required for this session. Although participants enjoyed learning about themselves through the Myers-Briggs testing, they thought the testing was too time-consuming. To reduce the length of the session, some suggested offering the Myers-Briggs testing before the course. There was great interest in adding material on conflict resolution (e.g., when or when not to get involved in lab conflicts, how to fire someone, how to mend bridges). Another suggestion was to invite more senior principal investigators to attend and participate as much as possible in the question-and-answer period.

Project Management. It was thought that this session might work better with the following format: a one-hour presentation followed by a one-hour small working group session headed by lab managers familiar with project management strategies (principal investigators or senior technicians). In the working group session, the participants could try to apply the principles learned in the previous presentation. Participants also thought that the addition of case studies based in a biological laboratory would make it easier to absorb the information.

Collaborations. Several participants recommended limiting the presentations to a few key points and case studies and then reserving a larger amount of time for the question-and-answer session. In addition to learning about collaborations with large laboratories at major research institutions or commercial operations, participants were interested in learning more about establishing collaborations between small independent laboratories. Participants wanted more information on how to approach someone about starting a collaboration, how collaborations affect the tenure decision, and how to establish authorship in a collaborative situation.

The Scientific Investigator Within the University Structure. This subject might be better suited to a panel format so that once the general structure of the university had been discussed, other related topics could be addressed. Of special interest was the information on how to assemble promotion materials and develop a "tenure" CV, the administrative structure of a university (e.g., the difference between a chancellor and a provost), and how to make the maximum use of university research resources. Participants were eager to learn more about the tenure process and fulfilling contract obligations.

Getting Funded. Participants appreciated that the panel included a representative from NIH to explain the internal structure of NIH and whom to contact with questions or problems, as well as a chair of an NIH study section. They said that they also wanted the panel to include representatives from a university grants and contracts office and from a private foundation that supports scientists, as well as a senior principal investigator from a major research university. Participants wanted an example of a successful R01 grant application (including a sample budget) as a handout for this session. (Course organizers attempted to obtain examples of successful grant applications from several sources but were unsuccessful in doing so.) Physician-scientists appeared to have many questions specific to their unique status at medical schools, where they have clinical duties in addition to research. Participants thought a breakout session for this subgroup, with specific information on career development awards and salary limits, would be useful.

Getting Published. Because all the participants had some experience in writing scientific papers, this session was geared toward the process of getting a paper published (e.g., selecting the appropriate journal, responding to reviewer comments, and learning more about the editorial process). Participants would have liked a variety of journals to be represented in the panel, rather than only a single, for-profit journal (although many found the process of paper submission at such a journal interesting). Participants were also interested in learning more about how to become reviewers and wanted examples of good and bad submissions.

Current Issues in Research Ethics. While several participants with Ph.D.s in the basic sciences commented that this talk was geared toward medical researchers, and as such, should be offered as a separate session just for M.D.s, others pointed out that it was very helpful to learn more about the human research guidelines and to not be intimidated by experiments dealing with human subjects. Other topics of interest were the production and retention of accurate tissue and medical records, the purpose and structure of Institutional Review Boards, and international research. Some participants thought that it was especially helpful that the bioethics speaker had a law degree because this provided a different perspective than a presentation by a Ph.D. or an M.D. There was also considerable interest in expanding the discussion on laboratory ethics and issues of misconduct, in addition to the "big picture" ethics of using human subjects in research. Perhaps the session could be reconfigured to have two speakers, one to deal with laboratory research problems and another to discuss the use of human subjects.

Time Management. This session was extremely popular, especially with participants who were trying to juggle work and family issues. Any concrete suggestions on how to save time or to be more efficient were greatly appreciated. While some participants felt it would make more sense to separate the M.D.s and Ph.D.s into separate sessions because of their different time management challenges, others thought it was a good idea to keep the groups together to get a better understanding of each other's challenges. The diverse panel (in terms of age, faculty position, mix of M.D. and Ph.D. degrees, and scientific discipline) was thought to be important to the success of this session.

Data Management and Laboratory Notebooks. Many participants recommended that this session be combined with the one on project management because the two sessions complemented each other. They thought that having a diverse panel (in terms of faculty position, M.D. and Ph.D. degrees, and scientific discipline) was an advantage. Participants thought it would be helpful to include several senior principal investigators to speak about their experiences in managing a variety of projects simultaneously. There was great interest in learning more about data management and, to a lesser extent, project management software. It was suggested that vendors be invited to display their software.

Mentoring and Being Mentored. Participants appreciated the concrete suggestions for creating an open and productive laboratory environment, including advice on mentoring individuals close in age to themselves (such as postdocs) and writing good recommendation letters. There was also significant interest in learning how to get the most out of being mentored. Participants liked the diverse composition of the panel (age, professional level, and mentoring style).

Roundtable Discussion: Problems in Scientific Management. This was one of the most popular sessions in the course because it allowed participants to apply what they had learned in practical situations and begin to achieve a sense of competence about laboratory management. The session was offered on the third day of the course after participants had completed sufficient training to solve case studies. However, the participants were getting tired by this point and would have appreciated having fewer than 10 cases to discuss as a group during the roundtable feedback session, especially because some of the cases had significant overlap. Five to six cases seemed to be the ideal number. A small-group format could have been used, but all participants would not have benefited from feedback from the entire audience.

Participants suggested including a senior principal investigator in each breakout group to help lend some perspective. However, the senior principal investigator should be reminded not to dominate the discussion process. If the course were to be held at a small research institution, it might be a good idea to use examples from a previous course so as not to embarrass the person submitting the problem (or potentially cause more serious problems with their department heads). It would speed up the session if the participants could review the case studies the night before or even to have the material sent to them before the course.

Finally, soliciting cases during rather than before the course might have resulted in a broader, more salient variety of case studies being discussed. Participants would have been exposed to the wide range of components that make up lab management and had a chance to think about how to apply the lessons they had learned to their own situations.

Gender Issues in the Laboratory. Participants wanted more statistics (perhaps as "ammunition" to take back to their departments). They also suggested that a handout containing recommended reading on the subject be included in future presentations. Participants wanted to expand the talk beyond women and raising children to include discrimination in the workplace (including minorities) and specific strategies on how to support both male and female junior faculty and postdocs. Instead of having a single-speaker format, participants thought the session would benefit from having panel members who are at different career stages; who have spouses with similar time constraints; and who have spouses who contribute their time, not just income, to child care.

Technology Transfer. Because this session was offered concurrently with "Obtaining and Negotiating a Faculty Position" and attendance was optional, participants recommended that they be told ahead of time why it was worthwhile to attend such a session. It would appear that many universities have not educated their faculty or postdocs about the benefits of patenting or bringing a product to market, so some sort of pitch should be made before the session to attract attendees. It was also recommended that the panel include a technology transfer software specialist. Particpants would have appreciated sample completed forms for invention disclosure and boilerplate technology transfer agreements.

Obtaining and Negotiating a Faculty Position. This was a very popular session, mostly with postdocs rather than junior faculty who had recently gone through the process of finding a job. Participants were particularly eager to learn more about what is allowable in terms of negotiating (e.g., just how much back and forth is acceptable) and wanted more information on typical start-up packages, including sample faculty offers. Several participants suggested this would have been an ideal format for a workshop. Participants wanted the panel to consist of people with diverse perspectives—including individuals who had recently obtained their first faculty positions and others who had served on search committees.

The session also included information on obtaining tenure. Many junior faculty course participants were unable to attend because they were attending the concurrent session on technology transfer. They strongly recommended that the topic of obtaining tenure be covered in a separate session.

Participants who were physician-scientists wanted to know when it was necessary to obtain legal advice for negotiating clinical duties and call schedules. Participants also wanted tips about negotiating a job for a spouse (especially in locations with only one university).

Budgets and Budgeting. Participants thought this session could be combined with the "Getting Funded" session. Participants thought a panel session, with at least two senior principal investigators, and possibly a workshop or small discussion group section, would be ideal. Participants wanted more information on how to construct a reasonable budget for the first R01 grant application—how much to allocate for salaries, fringe benefits, equipment, and supplies. As such, sample budget forms (perhaps in electronic format on a CD) would be of great use. Participants also wanted specific information about what NIH (or the National Science Foundation) allows in terms of salaries and how to split salaries between multiple grants or funding sources. Other issues that were of particular interest were equipment ownership (regarding NIH grants), indirect versus direct costs, and how to make the most out of start-up funds.

APPENDIX I

Focus Group Participants

The following faculty and postdoctoral fellows provided feedback on the course at various stages of development:

Suzanne Admiraal, Harvard Medical School
Matthew Anderson, Massachusetts Institute of Technology
Gerard Blobe, Duke University
Azad Bonni, Harvard Medical School
Doris Brown, Wake Forest University
George Daley, Whitehead Institute for Biomedical Research
Ricardo Dolmetsch, Stanford University
Robert Flaumenhaft, Harvard Medical School
Lisa Glickstein, Tufts University
Lindee Goh, Massachusetts Institute of Technology
William C. Hahn, Harvard Medical School
Bill Kobertz, University of Massachusetts
Klaus R. L. Nüsslein, University of Massachusetts–Amherst
Patrick O'Brien, Harvard Medical School
Konstantine Severinov, Rutgers University
Brent Stockwell, Whitehead Institute for Biomedical Research
Catherine Wu, Brigham and Women's Hospital

APPENDIX 2

Model Laboratory Leaders

The Workshop in Basic Laboratory Leadership Skills was developed by Christine Harris, Ed.D., executive coach and management consultant, and Joan C. King, Ph.D., Tufts University School of Medicine, and principal, Beyond Success. As part of their preliminary needs assessment, Dr. Harris and Dr. King designed a questionnaire that was completed by the following 41 principal investigators, regarded as model laboratory leaders by their peers, students, or postdoctoral fellows:

Cornelia Bargmann, Howard Hughes Medical Institute and University of California–San Francisco
John Boothroyd, Stanford University
Gail H. Cassell, Eli Lilly and Company
Thomas R. Cech, Howard Hughes Medical Institute and University of Colorado–Boulder
M. Paul de Koninck, University of Laval
Tamara L. Doering, Washington University in St. Louis
Ann Etgen, Albert Einstein College of Medicine
B. Brett Finlay, University of British Columbia
Elaine Fuchs, Howard Hughes Medical Institute and The Rockefeller University
William Goldman, Washington University in St. Louis
David Goltzman, McGill University
Susan Gottesman, National Institutes of Health
Ashley Haase, University of Minnesota
Margaret K. Hostetter, Yale University
Nancy Kanwisher, Massachusetts Institute of Technology
Marc Kirschner, Harvard University
Mark Krasnow, Howard Hughes Medical Institute and Stanford University
Joseph Majzoub, Harvard University
Kelly Mayo, Northwestern University
Louis J. Muglia, Washington University in St. Louis
Charles E. Murry, University of Washington
Erin O'Shea, Howard Hughes Medical Institute and University of California–San Francisco
Joseph Pagano, University of North Carolina
Suzanne Pfeffer, Stanford University
Barry I. Posner, McGill University
Howard A. Rockman, Duke University
John Roth, University of Utah
Thomas P. Sakmar, Howard Hughes Medical Institute and The Rockefeller University
Gerald Schatten, University of Pittsburgh
Lucy Shapiro, Stanford University
George Sheldon, University of North Carolina
John Sheridan, Ohio State University
Christopher Somerville, Carnegie Institution
Coimbatore B. Srikant, McGill University
Jerome Strauss, University of Pennsylvania
Jenny Ting, University of North Carolina
Christopher Wylie, Cincinnati Children's Hospital Research Foundation
Tony Wynshaw-Boris, University of California–San Diego
John D. York, Howard Hughes Medical Institute and Duke University
Hans Zingg, McGill University
Huda Y. Zoghbi, Howard Hughes Medical Institute and Baylor College of Medicine

APPENDIX 3

Course Schedule

BWF-HHMI Course in Scientific Management
HHMI Headquarters, Chevy Chase, MD
Saturday, July 27, to Wednesday, July 31, 2002

Saturday, July 27

3:00–6:00 p.m.	Registration
4:00–6:00 p.m.	Reception *Great Hall*
6:00–7:30 p.m.	Dinner *Dining Room*
7:30–8:00 p.m.	**Welcome** Enriqueta C. Bond, President, Burroughs Wellcome Fund *Auditorium*
8:00–9:00 p.m.	**Keynote Address** **Starting a Research Group in 1978: Are the Lessons Still Relevant?** Thomas R. Cech, President, Howard Hughes Medical Institute *Auditorium*

Rathskeller open until 11:00 p.m.

Sunday, July 28

7:00–7:30 a.m.	Breakfast
7:30–9:30 a.m.	**Workshop in Basic Laboratory Leadership Skills, Session I** Moderator: Martin Ionescu-Pioggia, Burroughs Wellcome Fund Speakers: Christine Harris, Management Consultant Joan C. King, Tufts University School of Medicine *Dining Room*
9:30–10:00 a.m.	Break *Great Hall*

10:00 a.m.–12:00 noon	**Workshop in Basic Laboratory Leadership Skills, Session I** Moderator: Martin Ionescu-Pioggia, Burroughs Wellcome Fund Speakers: Christine Harris, Management Consultant Joan C. King, Tufts University School of Medicine *Dining Room*
12:00–12:30 p.m.	Break
12:30–1:30 p.m.	Lunch *Dining Room*
1:30–4:00 p.m.	**Project Management** Moderator: Jim Austin, American Association for the Advancement of Science Speaker: Stanley E. Portny, Stanley E. Portny and Associates, LLC *Auditorium*
4:00–4:30 p.m.	Break *Great Hall*
4:30–6:00 p.m.	**Collaborations** Moderator: Victoria McGovern, Burroughs Wellcome Fund Speakers: Claire M. Fraser, The Institute for Genomic Research Rick Tarleton, University of Georgia Joseph DeRisi, University of California–San Francisco *Auditorium*
6:00–7:30 p.m.	Dinner *Dining Room*
7:30–8:45 p.m.	**Keynote Address** **The Scientific Investigator Within the University Structure** Introduction: Enriqueta C. Bond, Burroughs Wellcome Fund Speaker: Tony G. Waldrop, University of North Carolina–Chapel Hill *Auditorium*

Rathskeller open until 11:00 p.m.

Monday, July 29

7:00–7:30 a.m.	Breakfast *Dining Room*
7:30–9:30 a.m.	**Workshop in Basic Laboratory Leadership Skills, Session II** Moderator: Martin Ionescu-Pioggia, Burroughs Wellcome Fund Speakers: Christine Harris, Management Consultant Joan C. King, Tufts University School of Medicine *Auditorium*
9:30–10:00 a.m.	Break *Great Hall*
10:00 a.m.–12:30 p.m.	**Workshop in Basic Laboratory Leadership Skills, Session II** Moderator: Martin Ionescu-Pioggia, Burroughs Wellcome Fund Speakers: Christine Harris, Management Consultant Joan C. King, Tufts University School of Medicine *Auditorium*
12:30–1:00 p.m.	Complete Application Forms for Postcourse Coaching in Laboratory Leadership *Auditorium*
1:00–2:00 p.m.	Lunch *Dining Room*
2:00–4:00 p.m.	**Getting Funded** Moderator: Jim Austin, American Association for the Advancement of Science Speakers: Anthony Demsey, National Institutes of Health Bettie J. Graham, National Human Genome Research Institute Suzanne Pfeffer, Stanford University *Auditorium*
4:00–4:30 p.m.	Break *Great Hall*
4:30–5:30 p.m.	**Getting Published** Moderator: Jim Austin, American Association for the Advancement of Science Speaker: Angela Eggleston, Cell Press *Auditorium*
5:30–6:00 p.m.	Reception *Great Hall*

6:00–7:30 p.m.	Dinner
7:30–8:45 p.m.	**Keynote Address** **Current Issues in Research Ethics** Introduction: Maryrose Franko, Howard Hughes Medical Institute Speaker: R. Alta Charo, University of Wisconsin Law School *Auditorium*

Rathskeller open until 11:00 p.m.

Tuesday, July 30

7:00–7:45 a.m.	Breakfast *Dining Room*
7:45–10:00 a.m.	**Time Management** Moderator: Maryrose Franko, Howard Hughes Medical Institute Speakers: Richard M. Reis, Stanford University Sandra Schmid, The Scripps Research Institute Todd Golub, Dana-Farber Cancer Institute *Auditorium*
10:00–10:30 a.m.	Break *Great Hall*
10:30 a.m.–12:30 p.m.	**Data Management and Laboratory Notebooks** Moderator: Maryrose Franko, Howard Hughes Medical Institute Speakers: Howard Kanare, Construction Technology Laboratories Joseph M. Vinetz, University of Texas Medical Branch David J. Adams, Duke University Medical Center *Auditorium*
12:30–2:00 p.m.	Lunch *Dining Room*
2:00–3:30 p.m.	**Mentoring and Being Mentored** Moderator: Victoria McGovern, Burroughs Wellcome Fund Speakers: Dorothy E. Shippen, Texas A&M University David S. Roos, University of Pennsylvania Stephen L. Hajduk, University of Alabama–Birmingham *Auditorium*
3:30–4:00 p.m.	Break *Great Hall*

4:00–6:00 p.m.	**Roundtable Discussion: Problems and Solutions in Scientific Management** Moderators: Maryrose Franko, Howard Hughes Medical Institute Rolly L. Simpson, Burroughs Wellcome Fund Panelists: Thomas R. Cech, Howard Hughes Medical Institute Peter J. Bruns, Howard Hughes Medical Institute Klaus R. L. Nusslein, University of Massachusetts–Amherst Christine Harris, Management Consultant Kathy Barker, Author of *At the Helm: A Laboratory Navigator* *Auditorium*
6:00–6:30 p.m.	Reception *Great Hall*
6:30–7:30 p.m.	Dinner *Dining Room*
7:30–8:30 p.m.	Keynote Address **Gender Issues in the Laboratory** Introduction: Laura Bonetta, Course Coordinator Speaker: Gina Turrigiano, Brandeis University *Auditorium*
8:30–8:45 p.m.	*Break*
8:45–9:30 p.m.	**An Overview of Scientific Management: Course Summary** Speakers: Peter J. Bruns, Howard Hughes Medical Institute Victoria McGovern, Burroughs Wellcome Fund *Auditorium*

Rathskeller open until 11:00 p.m.

Wednesday, July 31

All guests check out of hotel. Bring luggage to Conference Center

7:00–8:00 a.m.	Breakfast *Dining Room*
8:00–10:00 a.m. (concurrent session)	**Technology Transfer** Moderator: Andrea Stith, Howard Hughes Medical Institute Speakers: Francis J. Meyer, A.M. Pappas & Associates Martha J. Connolly, EntreMed Christopher T. Moulding, Howard Hughes Medical Institute *Auditorium*

8:00–10:00 a.m. (concurrent session)	**Obtaining and Negotiating a Faculty Position** Moderator: Rolly Simpson, Burroughs Wellcome Fund Speakers: Chris M. Golde, Carnegie Foundation for the Advancement of Teaching Johannes Walter, Harvard Medical School Christopher Wylie, Children's Hospital Research Foundation in Cincinnati *Conference Room A (D125)*
10:00–10:30 a.m.	Break *Great Hall*
10:30–11:30 a.m. (concurrent session)	**Budgets and Budgeting: Survival Management Strategies 101** Moderator: James Austin, American Association for the Advancement of Science Speaker: Mike McClure, National Institute of Environmental Health Sciences, National Institutes of Health *Auditorium*
10:30–11:30 a.m. (concurrent session)	**Mentoring Panel Discussion** Moderator: Victoria McGovern, Burroughs Wellcome Fund Speakers: Elizabeth Keath, Saint Louis University E. Lynn Zechiedrich, Baylor College of Medicine *Conference Room A (D125)*
11:30 a.m.–12:00 noon	Complete Course Evaluation Forms
12:00 noon	Meeting Adjourns (Bag lunches available in Dining Room)
12:15 p.m.	Vans and Cabs Depart for Airports, Train Stations, or Other Local Addresses

APPENDIX 4

Speaker Biographies

David J. Adams, Ph.D., Associate Research Professor of Medicine, Department of Medicine, Duke University Medical Center

David J. Adams completed his undergraduate work in 1972 at the University of Iowa and obtained his Ph.D. in biochemistry from the University of Nebraska. In his postdoctoral work at the University of Texas Health Sciences Center in San Antonio, he moved his studies from steroid hormone action in the rat uterus to the understanding of estrogen-dependent growth in human breast cancer. He was a senior tumor biologist for 12 years at Burroughs Wellcome Company, Research Triangle Park, North Carolina, developing new anticancer drugs. He helped advance three compounds to clinical trial, one of which (Crisnatol) soon will be approved for therapy of brain tumors. In addition, he was involved in the development and the Investigational New Drug Application for Navelbine, an important drug for breast and ovarian cancer. Adams currently heads the Drug Discovery and Development Laboratory of the Duke Comprehensive Cancer Center. The mission of this laboratory is to develop novel, more selective anticancer drugs and drug combinations and to provide laboratory support for phase I and II clinical trials. Currently, his lab is collaborating with investigators at the Research Triangle Institute and the National Cancer Institute to develop the next generation of drugs based on the natural product camptothecin (analogs of which are used clinically to treat breast and colon cancer). In addition, Adams's group is evaluating new drug combinations for leukemia, work that has led to two clinical trials at Duke. Adams is a member of the Cancer Protocol Review Committee and Duke University Medical Center Institutional Review Board, which are responsible for protecting human subjects in clinical research.

Thomas R. Cech, Ph.D., President, Howard Hughes Medical Institute

Born in Chicago, Illinois, on December 8, 1947, and raised and educated in Iowa, Tom Cech received a B.A. degree in chemistry from Grinnell College. He obtained his Ph.D. in chemistry from the University of California–Berkeley and then conducted postdoctoral research in the Department of Biology at the Massachusetts Institute of Technology. In 1978, he joined the faculty of the University of Colorado–Boulder, where he became a Howard Hughes Medical Institute (HHMI) investigator in 1988 and Distinguished Professor of Chemistry and Biochemistry in 1990. In 1982, Cech and his research group announced that an RNA molecule from *Tetrahymena*, a single-celled pond organism, cut and rejoined chemical bonds in the complete absence of proteins. Thus, RNA was not restricted to being a passive carrier of genetic information but had an active role in cellular metabolism. This discovery of self-splicing RNA provided the first exception to the long-held belief that biological reactions are always catalyzed by proteins. In addition, it has been heralded as providing a new, plausible scenario for the origin of life. Because RNA can be both an information-carrying molecule and a catalyst, perhaps the first self-reproducing system consisted of RNA alone. Only years later was it recognized that RNA catalysts, or "ribozymes," might provide a new class of highly specific pharmaceutical agents, able to cleave and thereby inactivate viral RNAs or other RNAs involved in disease. Cech has received many national and international awards and prizes, including the Heineken Prize of the Royal Netherlands Academy of Sciences (1988), the Albert Lasker Basic Medical Research Award (1988), the Nobel Prize in Chemistry (1989), and the National Medal of Science (1995). In 1987, Cech was elected to the National Academy of Sciences and also was awarded a lifetime professorship by the American Cancer Society. Since 2000, Cech has been president of HHMI, headquartered in Chevy Chase, Maryland. He continues research on ribozyme structure and on telomerase in his Boulder, Colorado, laboratory.

R. Alta Charo, J.D., Associate Dean, Research and Faculty Development, University of Wisconsin Law School

R. Alta Charo is associate dean for research and faculty development at the University of Wisconsin Law School and professor of law and bioethics at the University of Wisconsin–Madison, where she is on the faculty of the law school and the medical school's Program in Medical Ethics. She offers courses on health law, bioethics and biotechnology law, food and drug law, medical ethics, reproductive rights, torts, and legislative drafting. In addition, she has served on the University of Wisconsin Hospital clinical ethics committee, the university's Institutional Review Board for the protection of human subjects in medical research, and the university's Bioethics Advisory Committee. She has also been a visiting professor at law and medical schools in Argentina, Australia, Canada, China, Cuba, France, Germany, and New Zealand. Charo is the author of more than 75 articles, book chapters, and government reports on topics such as voting rights, environmental law, family planning and abortion law, medical genetics law, reproductive technology policy, and science policy and ethics. She currently serves on the editorial boards of the *Journal of Law, Medicine and Ethics, Cloning: Science and Policy,* and the *Monash Bioethics Review*. Charo is a member of the board of the Alan Guttmacher Institute and the Foundation for Genetic Medicine and has been on the board of the Society for the Advancement of Women's Health Research and the board of the American Association of Bioethics. In addition, she was a member of the steering committee to found the International Association for Bioethics and has served as a consultant to the National Academy of Sciences Institute of Medicine and the National Institutes of Health Office of Protection from Research Risks. Since 2001, she has been a member of the National Academy of Sciences Board on Life Sciences. Charo obtained her B.A. degree in biology from Harvard in 1979 and her J.D. degree from Columbia University in 1982.

Anthony M. Coelho Jr., Ph.D., Review Policy Officer, Office of Extramural Research, Office of the Director, National Institutes of Health

Anthony M. Coelho Jr. received his doctoral degree from the University of Texas–Austin. As review policy officer, he is responsible for developing and implementing regulations, policies, procedures, methods, and guidance documents as well as governing National Institutes of Health (NIH) extramural review functions to ensure standard approaches to the peer review of grants, cooperative agreements, and research and development contracts. Before his current position, Coelho served for seven years as the chief of the Clinical Studies and Training Review Section at the National Heart Lung and Blood Institute (NHLBI) at NIH; he also served for seven years as a scientific review administrator at NHLBI/NIH. Before joining NIH, Coelho held positions as scientist in the Department of Physiology and Medicine and laboratory director at the Southwest Foundation for Biomedical Research in San Antonio. He also was a professor in the Department of Surgery/Neurosurgery, an associate professor in the Department of Pediatrics, and an associate professor in the Department of Dental Diagnostics Sciences at the University of Texas Health Sciences Center in San Antonio. He was the recipient of more than 18 years of grant and contract funding from NIH and other federal agencies. In addition, Coelho served for 12 years as a peer reviewer of grants and contracts for NIH and other federal agencies.

Martha J. Connolly, Ph.D., EntreMed (Now Director, Maryland Industrial Partnerships, Maryland Technology Enterprise Institute)

Martha J. Connolly is the director of the Maryland Industrial Partnerships (MIPS), a program of the Maryland Technology Enterprise Institute (MTECH). MIPS accelerates the commercialization of technology in Maryland by providing matching funds for collaborative R&D projects between companies and University System of Maryland faculty. Connolly holds a B.S. and an M.S. degree in chemistry from Stevens Institute of Technology and a Ph.D. in biomedical engineering from The Johns Hopkins University. She was a research faculty member at Johns Hopkins and later an assistant professor at the University of Maryland, Baltimore. She is the author of 36 publications in cardiovascular systems physiology. She is the former senior biotechnology specialist for the State of Maryland Department of Business and Economic Development. She was also a founder of Clairus Technologies and director of business development at EntreMed. Connolly is experienced in business development and technology commercialization in academia, government, and industry.

Joseph DeRisi, Ph.D., Assistant Professor, Department of Biochemistry and Biophysics, University of California–San Francisco
Joseph DeRisi completed his undergraduate degree in biochemistry at the University of California–Santa Cruz in 1992. In 1999, DeRisi earned his Ph.D. from the department of biochemistry at Stanford University, under the supervision of Patrick O. Brown. His graduate thesis was entitled "Whole genome gene expression studies of the budding yeast *Saccharomyces cerevisiae*." After graduating, DeRisi joined the University of California–San Francisco Fellows Program. One-and-a-half years later, he accepted an assistant professorship offer in the department of biochemistry and biophysics at the University of California–San Francisco. In his new lab, DeRisi has been extending genomic approaches to the study of malaria and human respiratory viruses.

Angela Eggleston, Ph.D., Senior Editor, Cell Press
Angela Eggleston received her B.S. degree in microbiology and M.S. degree in molecular genetics from the University of Notre Dame. She conducted her Ph.D. training in biochemistry and molecular biology with Stephen Kowalczykowski at Northwestern University Medical School and the University of California–Davis. Her doctoral studies concerned the role of the *Escherichia coli* RecBCD helicase/nuclease in the initiation of genetic recombination and resulted in a U.S. patent. For her postdoctoral studies, she made the first of four trans-Atlantic moves to work with Stephen West at the Clare Hall Laboratories of the Imperial Cancer Research Fund (now Cancer Research UK). There, she studied the opposite end of the recombination process, characterizing the *E. coli* RuvABC Holliday junction resolution complex. Her postdoctoral fellowship was sponsored in part by a Burroughs Wellcome Hitchings-Elion Fellowship. She then undertook a short postdoc with Fred Alt at HHMI/Children's Hospital in Boston, working on nonhomologous end joining in mammalian cells. From there, she went into scientific publishing and joined the Nature Publishing Group in London as an associate editor for *Nature Cell Biology*. In July 2001, she joined Cell Press in Cambridge, Massachusetts, as a senior editor and is responsible for molecular-biology-related manuscripts received for consideration for *Cell, Molecular Cell,* and *Developmental Cell*.

Claire M. Fraser, Ph.D., President and Director, The Institute for Genomic Research
Claire M. Fraser is president and director of The Institute for Genomic Research (TIGR) in Rockville, Maryland, which has been at the forefront of the genomics revolution since it was founded in 1992. Fraser led the TIGR teams that sequenced the genomes of *Mycoplasma genitalium*, the spirochetes *Treponema pallidum* and *Borrelia burgdorfei*, and two species of *Chlamydia*. She is now overseeing several major research projects, including the genomic sequencing of *Bacillus anthracis*, and is a member of

National Research Council committees on countering bioterrorism and on domestic animal genomics. She also has served on review committees of the National Science Foundation and the National Institutes of Health (NIH). Fraser has published more than 160 articles in scientific journals and books. She edited two volumes in the *Receptor Biochemistry and Methodology* series on neurotransmitter receptors, has been a reviewer for nine scientific journals, and currently serves on the editorial board of *The Journal of Biological Chemistry*. She is a former editor for *Comparative and Microbial Genomics* and for the *International Encyclopedia of Pharmacology and Therapeutics*. Before becoming TIGR's president in 1998, Fraser was the institute's vice president of research and director of its microbial genomics department. Before that, she worked as a researcher at NIH, including three years as chief of the section of molecular neurobiology at the National Institute on Alcohol Abuse and Alcoholism. She is a summa cum laude graduate of Rensselaer Polytechnic Institute and received a Ph.D. in pharmacology from the State University of New York at Buffalo. She has received numerous academic and professional honors, including professorships in both microbiology and pharmacology at The George Washington University.

Chris M. Golde, Ph.D., Senior Scholar, Carnegie Foundation for the Advancement of Teaching

Chris M. Golde is a senior scholar at the Carnegie Foundation for the Advancement of Teaching, where she works with the Carnegie Initiative on the Doctorate (CID). The CID seeks to develop and study experiments in doctoral education that are focused on preparing students to be stewards of their discipline. Before joining Carnegie, she was a faculty member at the University of Wisconsin–Madison, where her research focused on doctoral education. She is the lead author of *At Cross Purposes: What the Experiences of Today's Doctoral Students Reveal About Doctoral Education*, the report of the national Survey on Doctoral Education and Career Preparation, funded by the Pew Charitable Trusts. Her other work has focused on interdisciplinary and multidisciplinary graduate education and doctoral student attrition. Golde received a Ph.D. in education in 1996 and an M.A. degree in sociology in 1993 from Stanford University. She is also a graduate of Brown University (B.A. degree in linguistics, 1982) and Columbia University Teachers College (M.A. degree in student personnel administration, 1984).

Todd Golub, M.D., Charles A. Dana Investigator in Human Cancer Genetics, Dana-Farber Cancer Institute (Also Associate Investigator, Howard Hughes Medical Institute)

Todd Golub serves as director of the Cancer Genomics Program at the Whitehead Institute Center for Genome Research. He is also the Charles A. Dana Investigator in Human Cancer Genetics at the Dana-Farber Cancer Institute and associate professor of pediatrics at Harvard Medical School. Golub obtained his M.D. degree at the University of Chicago Pritzker School of Medicine and pursued clinical training in pediatric oncology at Boston Children's Hospital and the Dana-Farber Cancer Institute. He completed his postdoctoral research training at the Brigham and Women's Hospital and Harvard Medical School. His work as director of the Cancer Genomics Program at the Center for Genome Research focuses on discovering genomic and computational solutions to problems in cancer biology and cancer medicine, including the development of improved strategies for the diagnosis and treatment of cancer. Golub is recognized for his numerous contributions to cancer research, including the discovery of the most common genetic aberration in childhood leukemia and the development of genomics-based approaches to cancer diagnosis. He received the Discover Magazine Inventor of the Year Award, Health Category (2000), and the Judson Daland Prize of the American Philosophical Society for Outstanding Achievement in Clinical

Investigation (2001). In 2002, Golub was appointed Howard Hughes Medical Institute (HHMI) associate investigator in HHMI's competition for physician-scientists.

Bettie J. Graham, Ph.D., Program Director, National Human Genome Research Institute, National Institutes of Health
Bettie J. Graham received her undergraduate degree from Texas Southern University and her Ph.D. in virology from Baylor College of Medicine in 1972. She did postdoctoral research at Albert Einstein College of Medicine and in the intramural laboratory of the National Cancer Institute. In 1979, she was selected to participate in the Grants Associates Program at the National Institutes of Health (NIH); this was a one-year program to provide scientists with management experience. All of her positions at NIH have been on the program side. She has experience at the National Eye Institute, the Fogarty International Center, and now the National Human Genome Research Institute. She was one of the first program directors at the National Human Genome Research Institute, which was then called the National Center for Human Genome Research. Her research portfolio includes grants in mapping technology and sequencing technology by using mass spectroscopy. She also coordinates the institute's Small Business Innovation Research and Small Business Technology Transfer programs and its training and career development program. She has been invited to participate in many workshops dealing with the NIH process of funding research grants and research training and career development programs.

Stephen L. Hajduk, Ph.D., Professor, Department of Biochemistry and Molecular Genetics, University of Alabama–Birmingham (Now Director, Program in Global Infectious Diseases, Marine Biological Laboratory)
Stephen L. Hajduk received a B.S. degree from the University of Georgia in 1977. He pursued graduate studies at the University of Glasgow and the University of Amsterdam in the laboratories of professors Keith Vickerman and Piet Borst and obtained his Ph.D. in 1980. He did postdoctoral work in the Department of Physiological Chemistry at The Johns Hopkins University in Paul Englund's laboratory, studying the replication of mitochondrial DNA. Hajduk joined the faculty at University of Alabama–Birmingham (UAB) in 1983 and was promoted to full professor in 1992. He is a member of the UAB Center for AIDS Research and the Comprehensive Cancer Center. In 1991, he was named a Burroughs Wellcome Scholar in Molecular Parasitology, and, in 1994, he was named a Fogarty International Scholar. In 1998, he was named director of the UAB Center for Community Outreach Developments. Hajduk directed the biology of parasitism course at the Marine Biological Laboratory, Woods Hole, Massachusetts, from 1994 to 1998 and coordinates the annual molecular parasitology meeting at Woods Hole. Hajduk joined the Bay-Paul Center at the Marine Biological Laboratory in 2003 as director of the Ellison Program in Global Infectious Diseases. Hajduk is on the editorial boards for the *Journal of Biological Chemistry*, *Molecular and Biochemical Parasitology*, *Parasitology International*, and *Experimental Parasitology*. His research is supported by grants from the National Institutes of Health (NIH). His science education outreach programs are supported by the Howard Hughes Medical Institute, Robert Wood Johnson Foundation, the National Science Foundation, NIH, and the State of Alabama.

Christine Harris, Ed.D., Personal and Executive Coach and Management Consultant
Christine Harris received her undergraduate degree in psychology from Pomona College and her master's degree with a concentration in organizational development and her doctorate in adult development and education from Harvard University. For more than 18 years, Harris has helped individuals, groups, and organizations to clarify and commit to their visions and to develop the strategies and behaviors required to

express their inherent excellence. She uses her expertise in adult development and experiential learning to support individuals in realizing their full potential, to train and build collaborative management and work teams, and to design and implement change-management strategies. Her personal and executive coaching focuses on enhancing individuals' career satisfaction and on improving their interpersonal, group-process, and leadership skills. Harris's consulting clients include AT&T Bell Laboratories, Pfizer, Digital Equipment Corp., the Red Cross, the National Council on Library Resources, the American Association of Publishers, the National Engineering Foundation, The Vanguard Group, and Public Service Electric and Gas as well as several health care, educational, and service organizations. Her teaching experience includes seminars and courses on consulting theory and methods, action science, action inquiry, and adult developmental theory at the Harvard Graduate School of Education, Columbia University Teachers College, Boston College Carroll School of Management, the Wharton Business School Global Leadership and Teamwork program, and several American and European consulting firms. She also served on the staff of the National Training Laboratories Graduate Student Professional Development Program in experiential education and has taught workshops on leadership, conflict and meeting management, and effective communication. She is a member of the National Organizational Development Network, the Academy of Management, and the Cypress Consulting Group.

Howard Kanare, Senior Principal Scientist, Construction Technology Laboratories

Howard Kanare has been with Construction Technology Laboratories (CTL), Skokie, Illinois, and its parent company, the Portland Cement Association, since 1979. He has worked in technical services and applied research, and for 15 years he managed CTL's materials testing labs, including optical and X-ray spectroscopy, electron microscopy, analytical chemistry, and physical testing. He specified and supervised installation of all the major analytical instrumentation and developed three generations of laboratory information management systems. Kanare established procedures for sample handling and identification, instrument calibration and maintenance, report review, and quality assurance documents. His staff has been responsible for the unique development, production, and certification analyses for more than 15 standard reference materials under contracts with the National Institute of Standards and Technology. He is an active member and officer of the American Society for Testing and Materials (ASTM) Committee F-6 on Resilient Floor Coverings and principal author of several ASTM standards. He is the author of the American Chemical Society's best-selling book *Writing the Laboratory Notebook*, published in 1985. He is author or coauthor of more than 250 technical reports and more than 25 publications.

Elizabeth Keath, Ph.D., Associate Professor, Department of Biology, Saint Louis University

Elizabeth (Betsy) Keath is an associate professor of biology at Saint Louis University in St. Louis, Missouri. She received her doctorate in biochemistry and molecular biology in 1985, moving to a postdoctoral fellowship and then instructor position in the Mycology Center at the Washington University School of Medicine from 1985 to 1990. Her research interests focus on the relationship between dimorphism and virulence in the pathogenic fungus *Histoplasma capsulatum*, using an array of molecular, genetic, and immunological approaches to understand the fundamental cell biology of this medically relevant ascomycete. Her research has been supported by funding from the American Lung Foundation and by both a FIRST and R01 award from the National Institute of Allergy and Infectious Diseases. Most recently, she was the recipient of a scholar award from the Burroughs Wellcome Fund in molecular pathogenic mycology. Over the past 12 years at Saint Louis University, she has actively taught in the undergraduate and graduate curriculum, mentoring five Ph.D. students and six master's degree candidates, while serving on 20 thesis dissertation committees. She has served on various section committees for the American Society for Microbiology and has been an ad hoc member of the Bacteriology and Mycology Study Section 2.

Joan C. King, Ph.D., Professor Emerita, Tufts University School of Medicine

Joan C. King received her undergraduate degree in chemistry from Dominican College, her M.S. degree from the University of New Orleans, and her Ph.D. in neurosciences and psychology from Tulane University. King joined the faculty at Tufts University School of Medicine in 1979. During her 20 years at Tufts, she directed the medical neurosciences course and a research lab that focused on hypothalamic neurons that synthesize a peptide critical to reproduction. She received a National Institutes of Health (NIH) Career Development Award and her research was funded by both NIH and the National Science Foundation (NSF). As chair of the Department of Anatomy and Cellular Biology, she created and financed a multimedia resource center. King, together with a group of researchers, created and functioned as director of the NIH-funded Center of Excellence for Research in Reproduction. At the national level, King chaired the Population Research Committee, an advisory committee for the National Institutes of Child Health and Human Development, and several Committees of Visitors to NSF. Currently, King serves as past president of Women in Neurosciences and the Training and Development workgroup for the Society for Neuroscience strategic plan. King took early retirement to found her business, Beyond Success, which is devoted to enhancing people's potential. In addition to developing and presenting workshops and speaking publicly, she coaches individuals to express their highest levels of creativity. Her recently published book *Cellular Wisdom* articulates her coaching philosophy. In coaching researchers and administrators, King engages with each person to help them recognize their strengths, clarify their goals, hone their strategies, develop their leadership skills, and achieve success in a manner that generates personal and professional fulfillment.

Michael E. McClure, Ph.D., Chief, Organs and Systems Toxicology Branch National Institute of Environmental Health Sciences, National Institutes of Health

McClure is the chief of the Organs and Systems Toxicology Branch (OSTB) in the Division of Extramural Research and Training at the National Institute of Environmental Health Sciences (NIEHS) of the National Institutes of Health (NIH). In this capacity, he is responsible for and oversees a broad, national extramural research branch (with an annual budget of $90 million) with five program areas staffed with senior scientist administrators. He also serves as the science program administrator for the NIEHS Toxicogenomics Research Consortium, the joint government–industry (NIEHS–American Chemistry Council) Developmental Toxicology Extramural Research Program, and the OSTB Reproductive System Pathophysiology Research Program. Before joining NIEHS in late 1998, he served as the chief of the Reproductive Sciences Branch and head of the Reproductive Genetics and Immunology Unit in the Center for Population Research of the National Institute of Child Health and Human Development (NICHD). The latter branch program in reproductive biology, endocrinology, genetics, and medicine grew from $60 million to more than $100 million during his tenure. Both branch programs consist of a wide range of grant mechanisms for research and research training conducted by extramural investigators employed by for-profit private sector companies or not-for-profit academic institutions. McClure received his Ph.D. in 1970 from the

University of Texas Graduate School of Biomedical Sciences in Houston, where he completed graduate and postdoctoral training in cell biology and biochemistry. He was elected to the faculties of the University of Texas Graduate School of Biomedical Sciences and the University of Texas M.D. Anderson Hospital and Tumor Institute in Houston in 1972, where he served in the Department of Biochemistry. In 1973, he joined the faculty of the Department of Cell Biology at the Baylor College of Medicine in Houston. He was subsequently recruited in 1976 to the Department of Developmental Therapeutics at the University of Texas System Cancer Center in Houston as a joint research faculty. He then served as research administrator at NICHD in 1979 and went on to NIEHS in 1999.

Francis J. Meyer, Ph.D., Vice President, Enterprise Development, A. M. Pappas & Associates
Francis J. Meyer has 32 years of experience in academic technology transfer and the medical products industry. Meyer heads A. M. Pappas & Associates (AMP&A) Enterprise Group, a unit aimed at identifying and commercializing technologies emerging from the academic, government, and industry sectors. Before joining AMP&A, Meyer served as associate vice provost and director of the Office of Technology Development at the University of North Carolina–Chapel Hill, where he was responsible for managing, evaluating, patenting, marketing, and licensing the university's intellectual and tangible property. He was also responsible for new start-up company development, corporate-sponsored research, patent donations, and material transfer agreements. Meyer has taught a technology transfer course at the University of North Carolina–Chapel Hill Kenan-Flagler Business School to second-year MBA students. Before joining the university in 1995, Meyer worked for 10 years at The Johns Hopkins University School of Medicine, where he served as associate dean and director of the Office of Technology Licensing. During his academic technology transfer career, Meyer has evaluated 1,850 inventions, licensed 580 inventions, and assisted with the formation of 17 start-up companies based on university technologies (at Johns Hopkins and University of North Carolina–Chapel Hill). Before working at Johns Hopkins, Meyer was vice president of medical and regulatory affairs and a member of the management board at Extracorporeal, Inc., a Johnson & Johnson company. He received his B.S. degree in pharmacy from Loyola University in New Orleans and his Ph.D. in pharmacology from the University of Maryland–Baltimore. Meyer has served on various boards and committees of the Food and Drug Administration and the National Academy of Sciences as well as on industry association, academic, and professional boards and committees. He is currently a member of the Association of University Technology Managers, Licensing Executive Society, North Carolina Biosciences Organization Board of Directors, Research and Development Advisory Committee of the North Carolina Genomics & Bioinformatics Consortium, and the Wake County Technology Business Development Advisory Committee.

Christopher T. Moulding, Science Administrator for Intellectual Property, Howard Hughes Medical Institute
Christopher T. Moulding is the science administrator for intellectual property at Howard Hughes Medical Institute (HHMI), a position he has held since April 2000. On behalf of HHMI, Moulding reviews and approves the agreements between HHMI investigators and their counterparts in industry through their collaborations, consulting, and material transfer agreements. Moulding's career began as a research technician at the National Institutes of Health and Harvard Medical School, where he worked for Philip Leder, HHMI senior investigator in the Department of Genetics. Thereafter, he attended business school and received his MBA from Stanford

University in 1986. He held positions as manager of business development at Chiron Corporation and Systemix before joining the Office of Intellectual Property Administration at the University of California–Los Angeles in 1991, where he worked as a licensing officer. Moulding subsequently joined the California Institute of Technology in 1997 as director of life science technologies in the Office of Technology Transfer. He came to HHMI with 14 years of technology licensing experience from both industrial and academic sectors and with hands-on experience as a laboratory researcher.

Suzanne Pfeffer, Ph.D., Professor and Chairman, Department of Biochemistry, Stanford University School of Medicine
Suzanne Pfeffer is a professor of biochemistry and chairman of the Biochemistry Department at Stanford University. Her research is aimed at understanding the localization of receptors to specific subcellular compartments and how receptors move from one compartment to another. She was president of the American Society for Cell Biology in 2003 and is a member of *Science* magazine's Board of Reviewing Editors. She received her Ph.D. from the University of California–San Francisco.

Stanley E. Portny, President, Stanley E. Portny and Associates, LLC
Stanley E. Portny is an internationally recognized expert in project management and project leadership. During the past 30 years, he has provided training and consultation to more than 100 public and private organizations in the fields of pharmaceuticals, health care, consumer products, information technology, finance, insurance, telecommunications, and defense. He has developed and conducted training programs for more than 25,000 management and staff personnel in research and development, engineering, sales and marketing, information systems, manufacturing, operations, and support. Portny has been president of Stanley E. Portny and Associates, LLC, for 25 years. A Project Management Institute (PMI)-certified Project Management Professional and a PMI global registered education provider, Portny is the author of *Project Management for Dummies*, part of the widely acclaimed *For Dummies* series of business and professional books. He received his B.S. degree in electrical engineering summa cum laude from the Polytechnic Institute of Brooklyn and his M.S.E.E. degree and the degree of electrical engineer from the Massachusetts Institute of Technology. In addition, he studied at the Alfred P. Sloan School of Management and the George Washington University National Law Center. Further information is available at http://www.StanPortny.com.

Richard M. Reis, Ph.D., Executive Director, Alliance for Innovative Manufacturing, Stanford University
Richard M. Reis has had a long-standing interest in higher education, particularly in helping individuals prepare for, find, and succeed at academic careers in science and engineering. He is currently the executive director of the Alliance for Innovative Manufacturing at Stanford University and the executive director of the Stanford Research Communication Program. From 1997 to 2000, he was the director of Academic Partnerships at the Stanford Learning Laboratory, founded in 1997 by former Stanford president, Gerhard Casper. From 1982 to 1997, he was the executive director of the Stanford Center for Integrated Systems, a major research partnership between Stanford and 15 industrial companies. Reis is also a consulting professor in both the electrical engineering and mechanical engineering departments at Stanford. Among his many responsibilities is teaching a year-round seminar on preparing graduate students for academic careers in science, engineering, and business. The seminar is part of the Stanford University Future Professors of Manufacturing Program, which Reis also directs. He is the founder and editor of *Tomorrow's Professor Listserv*, a

biweekly electronic publication with more than 15,000 subscribers in 106 countries. Reis is the author of *Tomorrow's Professor: Preparing for Academic Careers in Science and Engineering* (IEEE Press, 1997). He holds bachelor's degrees in physical geography (1964) and physics (1965), both with honors, and a master's degree in science education (1968) from California State University–Los Angeles. He also holds a master's degree in physical science (1969) and a Ph.D. in higher education (1971) from Stanford University.

David S. Roos, Ph.D., Merriam Professor of Biology, University of Pennsylvania

David S. Roos is the Merriam Professor of Biology at the University of Pennsylvania. He also directs the Penn Genomics Institute, integrating research in genomics campuswide. Roos earned his undergraduate degree at Harvard College and a Ph.D. at The Rockefeller University. He joined the University of Pennsylvania in 1989 after a postdoctoral stint at Stanford University. Roos's current research interests focus on protozoan parasites, including *Toxoplasma* (a prominent congenital pathogen and opportunistic infection associated with AIDS) and *Plasmodium* (the causative agent of malaria). Work in the Roos laboratory encompasses molecular genetic and cell biological dissection of parasite pathogenesis; pharmacological, biochemical, and structural studies on drug targets and resistance mechanisms; studies on the evolution of eukaryotic organelles and replicative mechanisms; and the development and mining of parasite genome databases. Further information is available at *http://www.bio.upenn.edu/faculty/roos/*.

Sandra L. Schmid, Ph.D., Chairman, Department of Cell Biology, The Scripps Research Institute

Sandra L. Schmid joined the faculty of The Scripps Research Institute in 1988 in the department of cell biology and is currently a professor and chairman of the department. Work in her lab aims to define the molecular mechanisms of receptor-mediated endocytosis through the development and analysis of cell-free assays that faithfully reconstitute this process and confirmation of function through in vivo analysis. Biochemical, molecular biological, and morphological approaches are used to elucidate the mechanisms of coat assembly, cargo recruitment, and the regulation of these events by GTPases (e.g., dynamin) and kinases. Schmid received her B.Sc. in cell biology, with honors, in 1980 from the University of British Columbia and her Ph.D. in biochemistry in 1985 from Stanford University. She has served on the editorial board of *The Journal of Cell Biology* and *Trends in Cell Biology* and is a founding coeditor of the journal *Traffic*. She has two children, a son born during her last year as a postdoctoral fellow in cell biology at Yale, and a daughter, born four years later. Her outside interests include camping and hiking with her family. She has coached her daughter's recreation league soccer team for five years and her son's for two years before that.

Dorothy E. Shippen, Ph.D., Professor of Biochemistry and Biophysics, Faculty of Genetics, Texas A&M University

Dorothy E. Shippen received her B.S. degree from Auburn University and in 1987 was awarded a Ph.D. from the University of Alabama–Birmingham. Her Ph.D. thesis, which was carried out under the guidance of Anne Vezza, involved characterization of small ribosomal RNA genes from the human malaria parasite *Plasmodium falciparum*. For postdoctoral training, Shippen worked with Elizabeth Blackburn, beginning at the University of California–Berkeley and then moving in 1990 to the University of California–San Francisco. Her work in the Blackburn lab focused on the biochemistry of the telomerase RNP complex in the ciliated protozoan *Euplotes crassus*. A major contribution was the demonstration of a functional telomere DNA-templating domain within the telomerase RNA subunit. In 1991, Shippen joined the faculty of the Biochemistry and Biophysics Department at Texas A&M University. She currently serves on the editorial boards of *Molecular and Cellular Biology* and *Eukaryotic Microbiology*. Her work at Texas A&M continues to focus on telomeres and telomerase, with a major emphasis on telomerase-telomere interactions in *Arabidopsis thaliana*, a new model system for telomere biology developed by the Shippen laboratory.

Rick Tarleton, Ph.D., Distinguished Research Professor, Department of Cellular Biology, University of Georgia
Rick Tarleton received his B.A. degree in biology (cum laude) from Wake Forest University in 1978, his M.S. degree in microbiology from Texas A&M University in 1980, and his Ph.D. in biology from Wake Forest University in 1983. He joined the faculty of the University of Georgia in 1984 and is currently distinguished research professor in the Department of Cellular Biology at the university. In 1986, he was a visiting scientist at Brunel University, London. His research focuses on mechanisms of immunity and disease in *Trypanosoma cruzi* infection (a causative agent of human Chagas disease) and vaccine development for *T. cruzi*. From 1995 to 2000, he was a recipient of a Burroughs Wellcome Fund Scholar Award in Molecular Parasitology. Tarleton was founding director of the Center for Tropical and Emerging Global Diseases at the University of Georgia from 1998 to 2001. He is a member of the Wake Forest University Board of Visitors and was a member of the National Institutes of Health tropical medicine and parasitology study section from 1996 to 2000. He serves on the editorial boards of the journals *Infection and Immunity* and *Experimental Parasitology*.

Gina Turrigiano, Ph.D., Associate Professor, Department of Biology and Center for Complex Systems, Brandeis University
Gina Turrigiano is an associate professor in the Department of Biology and the Center for Complex Systems at Brandeis University. She received a B.A. degree in 1984 from Reed College and a Ph.D. in 1990 from the University of California–San Diego. She has held postdoctoral fellowships at the University of California–San Diego (1990) and Brandeis University (1990–1993). In 2000, Turrigiano was awarded the prestigious MacArthur fellowship for her work on homeostatic forms of synaptic plasticity that contribute to learning and development. Turrigiano is also a recipient of a National Institutes of Health career development award and Sloan Foundation Fellowship. Currently she is an associate editor for *Neuron* and is on the editorial board of the *Journal of Neurophysiology*. She collaborates with her husband Sacha Nelson, who is also in the Department of Biology at Brandeis University. Together, they raise their two sons, Gabriel and Raphael.

Joseph M. Vinetz, M.D., Associate Professor, Departments of Pathology, Internal Medicine, and Microbiology and Immunology, University of Texas Medical Branch–Galveston
Joseph M. Vinetz received a B.S. degree in biology and in history of science and medicine from Yale University in 1985 and an M.D. degree from the University of California–San Diego School of Medicine in 1991. While a medical student, he was a Howard Hughes Medical Institute (HHMI)/National Institutes of Health (NIH) research scholar and worked on malaria in the Laboratory of Parasitic Diseases under the supervision of Louis Miller. He trained in internal medicine and infectious diseases at The Johns Hopkins School of Medicine and was an HHMI physician postdoctoral fellow in the Laboratory of Parasitic Diseases at NIH in the laboratory of David Kaslow. In 1998, he joined the faculty of the University of Texas Medical Branch, where he has continued his work on the molecular and cellular mechanisms

of *Plasmodium ookinete*–mosquito midgut interactions, focusing on ookinete-secreted chitinases. He also initiated a bedside-to-bench research program to study human leptospirosis in the Peruvian Amazon region of Iquitos. He is a member of the Center for Tropical Diseases at the University of Texas Medical Branch–Galveston, the American Society of Tropical Medicine, the ASTMH Clinical Group, the Infectious Diseases Society of America, and the American College of Physicians. In 2001, he was a participant in the Gorgas Memorial Institute's Expert Course in Clinical Tropical Medicine in Lima, Peru.

Tony G. Waldrop, Ph.D., Vice Chancellor for Research and Economic Development and Professor of Cell and Molecular Physiology, University of North Carolina–Chapel Hill
Tony G. Waldrop, a Columbus, North Carolina, native, was a Morehead Scholar at the University of North Carolina–Chapel Hill in the 1970s. Before joining the faculty there, he was a professor of molecular and integrative physiology and vice chancellor for research at the University of Illinois at Urbana–Champaign and also was an interim graduate school dean there. At the University of Illinois, he led efforts to create a university-associated research park. Waldrop's research has been supported by the National Institutes of Health and the American Heart Association (AHA). AHA selected him as an established investigator. At Illinois, Waldrop was a university scholar, the premier recognition accorded to faculty by their colleagues. His research interests are hypertension, developmental neurobiology, and the effects of hypoxia (low oxygen) on brain stem neurons. He has published more than 100 peer-reviewed journal articles and book chapters.

Johannes Walter, Ph.D., Assistant Professor, Department of Biological Chemistry and Molecular Pharmacology, Harvard Medical School
Johannes Walter obtained his B.A. degree in biochemistry at the University of California–Berkeley. He earned his Ph.D. in molecular biophysics and biochemistry at Yale University, where he worked with Mark Biggin on the control of *Drosophila* development by homeodomain transcription factors. For his postdoctoral studies, Walter joined John Newport in the Department of Biology at the University of California–San Diego. In 1999, Walter joined the Department of Biological Chemistry and Molecular Pharmacology at Harvard Medical School as an assistant professor. His lab works on the molecular mechanism and regulation of eukaryotic DNA replication.

Christopher Wylie, Ph.D., Director, Division of Developmental Biology, Cincinnati Children's Hospital Research Foundation
Educated in Kenya and England, Christopher Wylie received a B.Sc. degree and Ph.D. at the University of London, United Kingdom. He was faculty member in the Departments of Anatomy at University College London and then at St. George's Hospital Medical School. He moved to the F. J. Quick Chair of Biology at Cambridge University in 1989. In 1994, Wylie became the Martin Lenz Harrison Chair of Genetics and Development at the University of Minnesota. In 2000, he became the William Schuber Chair and Director of the Division of Developmental Biology at the Children's Hospital Research Foundation in Cincinnati. Wylie's research interests include the basic mechanisms of early vertebrate development, using *Xenopus* and mouse as model systems to study, in particular, the molecular basis of cell migration, cell architecture, and cell adhesion and specification. Activities outside the lab include being editor in chief of *Development*, an international journal of developmental biology; membership of study sections; president of the Society for Developmental Biology; and, occasionally, golf.

E. Lynn Zechiedrich, Ph.D., Assistant Professor, Department of Molecular Virology and Microbiology, Baylor College of Medicine

E. Lynn Zechiedrich has been an assistant professor in the Department of Molecular Virology and Microbiology at Baylor College of Medicine since 1997. She serves on the executive committee for the Houston-wide Program for Structural and Computational Biology and Molecular Biophysics and is a faculty member of additional inter-institutional programs joining Baylor College of Medicine with Rice University, the M.D. Anderson Cancer Center, the University of Houston, and the University of Texas. Zechiedrich earned her Ph.D. in biochemistry from Vanderbilt University and was a postdoctoral fellow at the University of California. The Zechiedrich laboratory studies the cellular roles of the bacterial DNA topoisomerases, which are required for every aspect of DNA metabolism. The topoisomerases are the cellular targets for several classes of antimicrobial agents, including the now famous Cipro, and her group uses a combination of genetics, molecular biology, bioinformatics, and genomic analyses to determine how bacteria resist drug treatment. For additional information, see *http://www.bcm.tmc.edu/~elz/*.

APPENDIX 5

Sample Session Evaluation Form

Badge Number:__________

Session Title:
Speakers:

Was the format for the session appropriate for the topic? (i.e., speaker, panel, workshop)?

☐ Yes
☐ Maybe
☐ No

Comments:____

____

____

The amount of time devoted to the session was:

☐ Too long
☐ About right
☐ Too short

Check the appropriate box

Rate the session in terms of the	1 Far exceeded my expectations	2 Exceeded my expectations	3 Met my expectations	4 Fell short of my expectations	5 Fell far short of my expectations
Content					
In-class exercises					
Relevance to your role as a scientific manager					
Overall value of the session					

Which parts of the session were most useful to you? ______________________________

____

____

____

What would you like to know more about? ______________________________________

____

____

____

Were any topics not as important to include in this session? Why? __________________

____

____

____

____

Other comments:____

____

____

____

____

Would you like to see this session included in a future version of the course?

☐ Yes
☐ Maybe
☐ No

APPENDIX 6

Course Summary Evaluation Form

Badge Number:__________

Check the appropriate box

Rate the course in terms of	1 Far exceeded my expectations	2 Exceeded my expectations	3 Met my expectations	4 Fell short of my expectations	5 Fell far short of my expectations
Overall quality of the course					
Relevance of the complete course to your role as a scientific manager					
Opportunities at the course for networking					
Degree of change the course will promote in the way your lab is managed and organized					

Overall course length:

☐ Too long
☐ About right
☐ Too short

Comments:____

____

____

Which parts of the course were most useful to you?____________________

____

____

____

What additional topics would you include in future course offerings? __________

____

____

____

Were there any topics you recommend excluding from the course and why? ________

____

____

____

Were any of these sessions redundant with each other? ________________________

____

____

____

Was the level of teaching in the course appropriate to your degree of experience in laboratory management?

☐ Too advanced
☐ About right
☐ Too basic

Comments: ____

____

____

The number of participants in the course (120) was

☐ Too many
☐ About right
☐ Too few

Comments: ____

____

____

Would you recommend this course to an associate?

☐ Yes
☐ Maybe
☐ No

Comments: ____

____

____

How can we improve or enhance this kind of course in the future? ______________

____

____

____

Rate the course activities in terms of their importance to you (rate only those you attended).

Check the appropriate box

	1 Most important	2 Somewhat important	3 Average	4 Less important	5 Least important
Sessions					
Workshop in Basic Laboratory Leadership Skills					
Project Management					
Collaborations					
Getting Funded					
Getting Published					
Time Management					
Data Management and Laboratory Notebooks					
Mentoring and Being Mentored					
Roundtable Discussion: Problems and Solutions in Scientific Management					
Concurrent Sessions					
Technology Transfer					
Obtaining and Negotiating a Faculty Position					
Budgets and Budgeting					
Mentoring Panel Discussion					
Keynote Talks					
The Scientific Investigator Within the University Structure					
Current Issues in Research Ethics					
Gender Issues in the Laboratory					

Other comments about the course:______________________________

Do you think lab management skills can be effectively taught by methods other than an in-person course?______________________________

Rank the methods of offering the course by their effectiveness in teaching you laboratory management skills (1—most effective to 5—least effective).

_____ In-person course like this one (length could vary)
_____ Book
_____ DVD
_____ Book and DVD
_____ Web

Is there anything else you would like us to know about the course? _______________
____
____
____

Index

T