National Science Foundation
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BCM Baylor College of Medicine

BEYOND the BEAKERS:

SMART Advice for Entering Graduate Programs in the Sciences and Engineering

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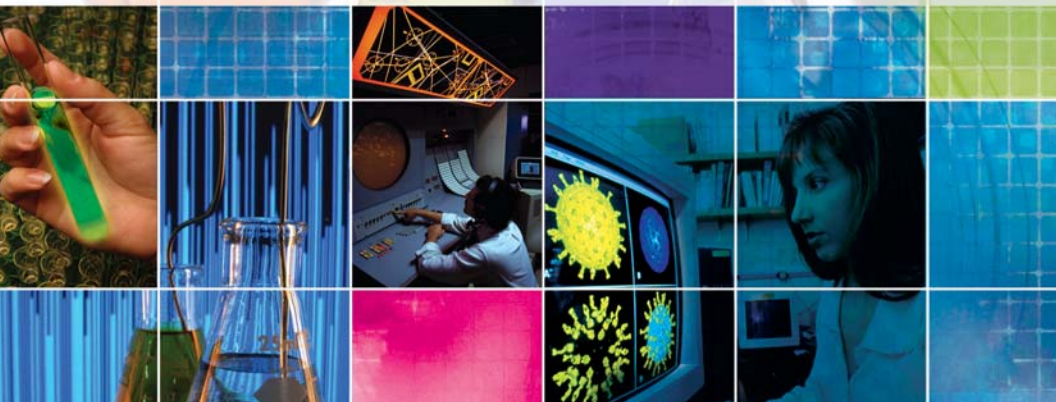
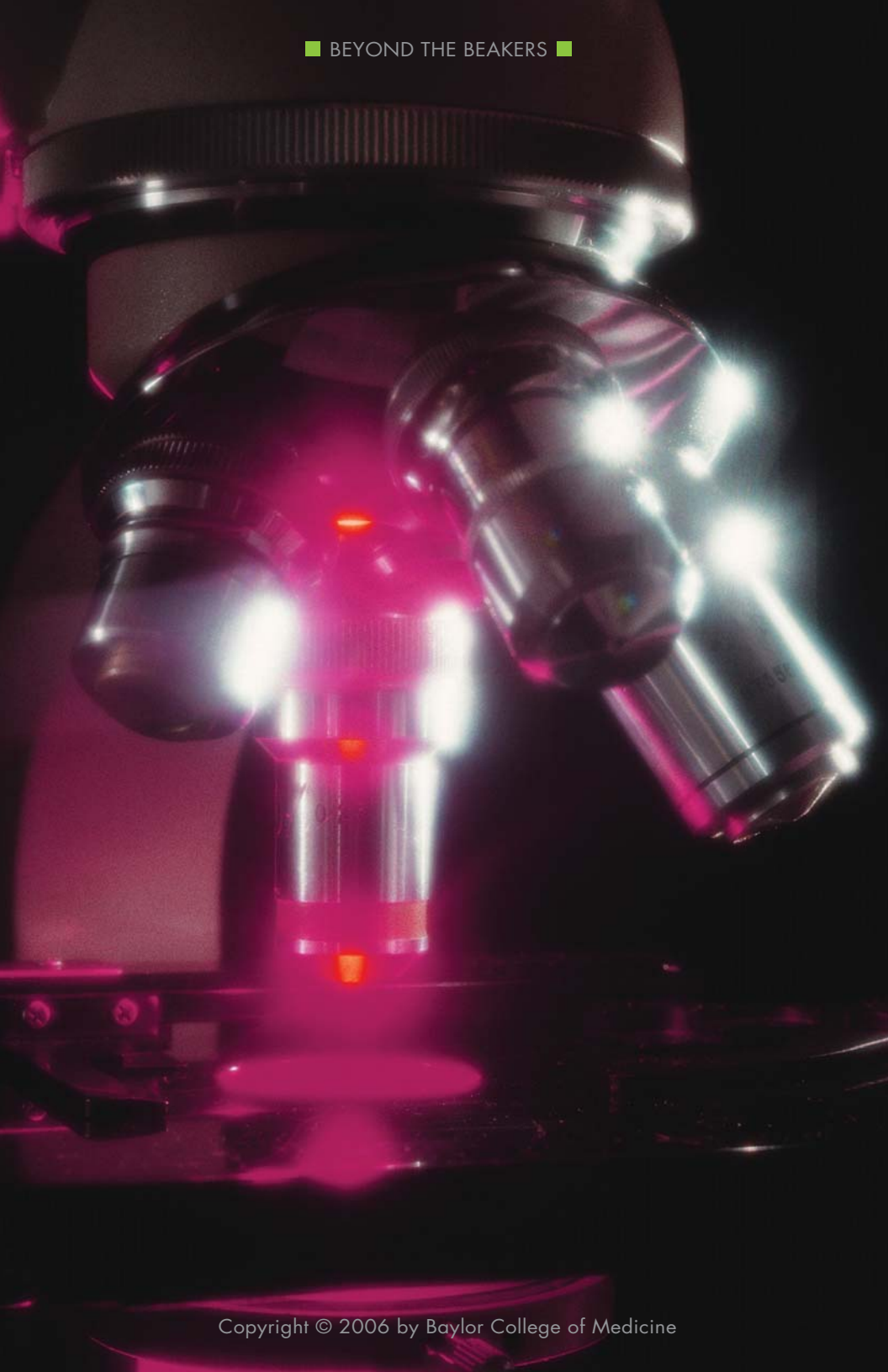
Gayle R. Slaughter, Ph.D.





INTRODUCTION

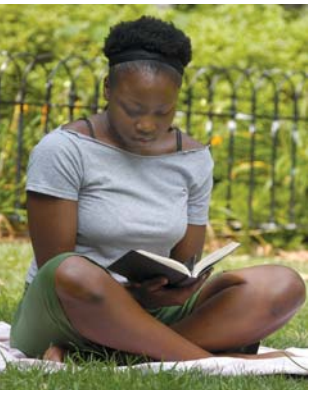
Why do I think this book might be useful?

This is the most exciting time in history to become a scientist or engineer. Our imagination is often our limit to what we can discover or do. Our achievements enhance the world around us at a dizzying pace. New diagnostic tools, medicines, new materials including those made by nanotechnology, miraculous computers, lasers and electronic devices are transforming our world. But America is not producing enough scientists and engineers to maintain our position as world leaders in science and engineering. Many factors affect the number of Americans entering STEM (science, technology, engineering and mathematics) fields. Numerous studies have emphasized the importance of attracting STEM professionals from every group in the country. We cannot afford to lose the talents of women, of African Americans, Hispanics, Native Americans, or those with physical challenges. In fact, we can't afford to lose the talents of any Americans who could become STEM professionals. We must use a variety of strategies to help people with the desire, intellectual ability, creativity and perseverance to continue to gain the education to become the next generation of leaders in STEM. A number of programs provide opportunities for undergraduates to conduct research or gain practical real life experiences. Graduate schools and organizations provide salaries or stipends to support advanced level study, especially at the Ph.D. level.

Some of you have access to people who can guide you through the process of applying to graduate school. However, many people using this book may not feel they have sufficient guidance to move to the next level of their education. A lot of people in STEM careers do not come from families with a history of advanced education. Some of the outstanding Ph.D. students at my institution are first generation high school graduates.

This guidebook has been developed to help undergraduates understand and prepare for entering graduate school in the sciences or engineering. The elements presented here have been developed over the past 17 years that I have worked with undergraduates, Ph.D. students and post-doctoral fellows through the Graduate School of Biomedical Sciences of Baylor College of Medicine. The undergraduate majors of my students have spanned the spectrum of STEM, including biology, chemistry, computer science, engineering, mathematics, physics and every other imaginable area. Like research projects, this material has evolved - from pointers provided to puzzled students into more formal workshops, many of which have been presented a

number of times. Thanks to funding from the National Science Foundation (NSF HRD 9906394), these pointers have been assembled into a guide that I hope will make it easier for students to apply to and be accepted by the graduate school of their choice. The guidebook includes several sections, each useful at a different point in your education. You may come back to different sections at different times. Some sections refer you to other specialized resources.



The first section provides pointers on making the most of undergraduate research and work experiences. I've worked with more than 1,600 students in our SMART summer undergraduate research program and helped many of them apply for Ph.D. programs. Practical, real-life experiences are prized by graduate school admissions committees. Hundreds of research/work opportunities are available for resourceful undergraduates, but you have to maximize the impact of your experience.

The SMART GRE prep workshops were developed in a very unexpected way. I saw too many promising scientists who were not accepted by the graduate schools they wanted to attend because of their GRE scores – and only their GRE scores. I took GRE practice tests myself and tried to provide pointers and encouraged students to create study groups – but it didn't help. So, when I identified a NSF Gender Equity grant with a more flexible budget than for typical summer research programs, I asked for funds to have a GRE prep company do diagnostic testing and teach a prep course. The review panel decided to fund the grant, but eliminated the funding for the GRE course and had the audacity to recommend that I teach the course. I said some very bad words about the sanity and intelligence of the review panel. What does a biochemist, a molecular biologist know about teaching GRE prep? How could I possibly find the time to do one more thing? Then I cried and went to bed. When I got up the next morning, I decided that they had given me $95,000 to help students enter graduate school, so I'd try to teach GRE prep, but I needed help. I was fortunate to "bump into" a BCM student who decided to complete a master's degree, but not a Ph.D. Tina Corkran had helped her mother teach SAT prep. Tina began working with me to develop GRE prep workshops as soon as she finished her thesis, which wasn't until the summer had started. Some days we were making up exercises as we entered the room. But, we had remarkable results with our first group of 10 students. Their scores improved an average of 370 points between the first and last practice exams! We continued to develop workshops as we found other donors who recognized the importance of helping students do their best on the GRE. Laurie Connor, Ph.D. joined the team after I acquired a major grant from the NSF to test our model at five women's college campuses. Over the years the changing structure and content of the GRE has

been a great challenge. Our guidebooks for students and faculty have been updated a number of times to keep pace with changes to the GRE. But the SMART Program and other campuses have demonstrated that students can improve their scores through workshops and individual study. Many students improved their scores by 200 points or more using the strategies outlined in this book. Our hope is that the information in this book will provide inspiration and guidance to help you do your best on the GRE and reach your career goals. But the moral of the story is that as scientists and engineers we learn to be problem solvers and you never know what problem you'll find yourself solving next.

One section of the book includes information from some of the "Thriving, Not Just Surviving, as a Scientist" skills workshops I present at BCM. In the early stages of my career, I spent a lot of time trying to find out how to do things right. As a scientist/educator I created a series of workshops to provide advice on developing the practical skills we need as scientists. The workshops that are of greatest relevance to undergraduates are included in this book. Hopefully, the pointers in this book will help you do a good job and save time and stress. We love science or engineering, but having a life is important, too.

I developed workshops on applying for graduate school for the undergraduates and technicians working at Baylor College of Medicine. Graduate schools are looking for American educated students who have taken good advantage of their opportunities and can relate their experiences and preparation in knowledgeable language. Understanding and preparing for the application process can reduce the stress you feel and result in greater opportunities to expand your knowledge and skills in the environment you chose.

Good luck as you continue your education. The lives of people around the world have been enriched through science and engineering. New discoveries and applications of knowledge will continue to develop – as long as we have people who are willing to gain the education and persevere to make today's dreams and crazy ideas, tomorrow's realities.

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Chapter One: Research and Work Experience

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

Types of Undergraduate Research/Work:

1. Academic year experiences

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

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

2. Summer research

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

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

Applying to Summer Research Programs:

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

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

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

Communicating with Program Directors:

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

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

Choosing a Project/Lab:

Consider things like:

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

Expectations of Research Program Participants:

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

Making the Most of Your Research Experience:

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

Finalizing Your Work:

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

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

Capitalizing on Your Research/Work Experience

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

Summer Research Then and Now

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

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

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

Chapter Two: Doing Your Best on the GRE

The GRE is a standardized examination administered by ETS (Educational Testing Service). Because graduate school applicants' majors, courses, schools, difficulty and currency of courses vary, some graduate schools rely on GRE scores as the only data with a consistent scale. While GRE scores have a limited predictive value in identifying talented scientists or engineers, some graduate schools use your scores to make decisions regarding selection of students. The weight given to your scores varies between schools, so it would be beneficial to contact program administrators/directors or admissions officers and inquire about the importance of the GRE in the selection process. It is also valuable for you to be familiar with the exam and know how you might improve your score.

General Information:

The GRE website (http://www.gre.org) contains a lot of useful information about the test, including the cost, the opportunity to register for the test and information on acquiring resources to prepare for the GRE.

- The exam is given year-round; testing centers are listed on the website
- The exam is administered on a computer. More about this later!
- Currently you may take the test once a month, up to 5 times a year.
- You receive your scores on the verbal and quantitative sections immediately after taking the computer-graded exam.
- Because trained human graders score the writing sections, you and the schools you designate to receive them will receive your writing scores later by mail.
- Some graduate schools require that you take a subject GRE. These are given twice a year, in November and April. Generally, you can choose among the different subject tests offered and take the test the program requires or the one on which you expect to do the best.

Reasons for Preparing for the GRE

1. You can improve your GRE skills and scores with study and practice.
2. The skills you develop while preparing for the GRE (vocabulary, logical writing, etc.) will benefit you in ways other than improving your score on a standardized test. You will learn many new words as you progress through graduate school. The same skills you develop improving your

GRE vocabulary will be applicable to learning new scientific terminology. The new vocabulary you learn will make you a more effective writer and speaker in graduate school and later in your career. Learning precise language to characterize people will be an asset in writing essays about yourself (personal statement), or even writing letters of recommendation someday.

What Good is a Sophisticated Vocabulary to a Scientist or Engineer?

Why would a scientist or engineer benefit from expanding their vocabulary to include words that are more familiar to an English or sociology major? A Ph.D. is not a technical degree. It denotes the highest level of formal education. And you never know where an education will lead you. You might become a faculty member, even the dean of a graduate school in a university and need to interact with people from many different departments who speak a different "language" than that typically used by scientists or engineers.

Growing up in the Rio Grande Valley of Texas, Richard Tapia, Ph.D. never imagined that he would become a world famous mathematician and be appointed to national committees that study education of mathematicians, engineers and scientists. His colleagues speak an educated language, as do many people in leadership positions.

Enriching my vocabulary became personal to me the day that I was to present a talk for members of the National Academy of Sciences. I arrived very early, so early that the committee members invited me to have lunch with them. It wasn't long before it was clear that the conversation sounded like "GREse". I not only understood those erudite leaders, I could participate in the discussion because I had been helping students build their vocabulary. Can you image how nervous I would have been when it was time to present my talk if I had been intimidated by the lunch conversation? The talk was very well received and I learned another lesson in the value of general knowledge.

What is a Good GRE Score?

- 550+ on the individual quantitative and the verbal sections are good scores
- 4.5-5 in writing is a good score
- 700+ in each area, the quantitative and the verbal, is a great score.
- 5-6 in writing is a great score.
  The scoring scales will change in October, 2006.

- Scoring in the 70th percentile is strong and recommended by some Ph.D. programs. A few programs focus on applicants with scores above the 90th percentile.

Consult program administrators or faculty regarding applying to a school that lists average GRE scores that are higher than yours. The GRE score is only one component of your application. Many schools accept students with lower GRE scores than they indicate they desire.

Resources to Prepare for the GRE

1. Use the ETS website: http://www.gre.org for information, sample questions, diagnostic tools and strategies for test preparation.
2. Purchase or borrow review book(s) to help you prepare to do your best on the GRE. There are a number of useful review books including those produced by ETS, Cambridge, Kaplan, Princeton, and even Cliff's Notes. The test does change, so it is best to use current review books. If your scores on specific sections are low consider more preparation with specific books like the Kaplan Math Review or the novel Tooth and Nail by Elster and Elliot (more about this resource later).
3. Check out prep-courses offered on your campus or through commercial organizations. Many courses cost hundreds of dollars and may not be necessary as long as you are motivated and use other resources wisely. How motivated can you be to save $800? Some course providers might give you a discount. It never hurts to ask if you can justify the request.

Preparing for the GRE

1. Understand the test and know what to expect.
2. Familiarize yourself with the test structure and rules.
3. Use diagnostic test results to develop a personal study plan.
4. Review your skills and build your knowledge. Use the workshops provided in this book for general strategies and review books for specific information. It is likely that it will take weeks to months to build your skills. Intensive cramming in a short time typically doesn't raise scores, except in the area of increasing your test familiarity. Building skills takes time. There are no short cuts to success.
5. Take practice tests (some on the computer). Take the official test when your scores plateau or you run out of time to take the test before application deadlines.

How Can GRE Scores Influence Your "Acceptance" to and by Graduate Schools?

Anjelica Gonzalez was an African American/Hispanic woman engineering major at Utah State University when she saw a flyer advertising the SMART Program and decided it sounded interesting. She found her place in science that summer, using her engineering skills to answer biological questions. Her application to BCM's Structural and Computational Biology and Molecular Biophysics Ph.D. Program was strong. The committee was especially impressed with her GRE scores, which had risen significantly after participating in the SMART GRE Prep Workshops. Anjelica was not only admitted, she was "accepted" by the faculty as a top candidate. The unique inter-institutional nature of the SCBMB Program and the eagerness with which faculty recruited her, convinced Anjelica to return to BCM to continue her education. Like most participants in the SCBMB program, she had to take a number of courses to build the interdisciplinary background required of students. She rotated through five labs, each with a different focus, before she found just the right place to conduct dissertation research.

While Anjelica was the second under-represented minority in the SCBMB Program, she was the first US woman to enter the program. Women of any ethnicity are still under-represented in mathematics, computational and engineering sciences. Anjelica found friends among other female Ph.D. students, including three African American women who started graduate school the same year and developed a friendship that helped them deal with many issues. As with most Ph.D. projects, Anjelica encountered problems, but she solved them. She developed an amazing system to use microscopes and computers to monitor the attachment and movement of immune cells in real time under defined conditions. She identified six molecules that are pivotal in attachment and spreading processes with applicability to immunology, atherosclerosis and cancer metastasis. A few weeks before she defended her dissertation, Anjelica tied for the

first place research presentation at the SCBMB Retreat. The day before she received her official diploma and hood signifying attainment of the Ph.D., she was notified that her dissertation project was selected as the most outstanding in the nation by the Federation of Clinical Immunology Societies. Yeah, girls can win the game, too. And they're not going to let a test stand in their way of achieving their dreams.

The GRE Computer Adaptive Test (CAT) (as of October, 2005)

1. Structure of the GRE CAT

Verbal	30 min	30 questions
Quantitative	45 min	28 questions
Analytical Writing		
Issue task	45 min (2 choices)	
Argument task	30 min (no choice)	

2. Adaptive Nature of CAT

- The CAT is adaptive, which means it reacts to your responses and adjusts the questions it gives you based on which questions you answer correctly.
- ETS has developed about 100,000 pre-tested questions, ranked in difficulty (easy, medium, hard). You are awarded different point values for answers depending on the difficulty of each question.
- Each question is randomly selected from a defined level.
- The difficulty of a question is adjusted based on your previous answers. If you get answers right, you get harder questions. If you get answers wrong, you get easier questions.
- Because you are penalized for not finishing the test, you should guess intelligently at the end if you are running out of time.

3. CAT Rules

- You must answer the questions in the order they appear.
- You must confirm each answer before you can see the next question. This is your chance to change an answer.
- You cannot go back to previously answered questions.

- You cannot skip questions. Eliminate answers that you can, guess intelligently.
- You cannot take calculators into the test.
- You cannot take paper into the test.
- The testing center will provide you with scratch paper.
- You may write anything you can remember on your scratch paper, even before the test begins (for example, math formulas or values of square roots).
- You should set up a numbering scheme on your paper so that you can keep track of answers you eliminate or write down key words from the reading passages.
- You must turn in your scratch paper when you finish the exam.

The GRE will still be given on a computer in 2006, but the CAT will be replaced by a test where everyone gets the same questions.

General Strategies for Improving GRE Scores: Since ETS changes the GRE about every two years, the best strategy Is to focus on building general skills on enhancing vocabulary, reading comprehension, logical thinking, mathematical comparisons, interpreting graphs and constructing logical essays.

1. Use information from web-sites:
   http://www.gre.org: test information, PowerPrep, on-line diagnostics
   http://ets.org/criterion/highered/: writing evaluation and advice.
2. Use the results of your diagnostic exams to focus your study efforts on areas in which you are weakest.
3. Create a personal study plan, focus on the areas in which you need most work.
4. Take an official prep-course, if the price is affordable.
5. Use strategies that fit your optimal mode of learning (individual studying, group studying, flash-cards, etc.).
4. Use multiple review books and resources, share resources with friends.
5. Take as many practice tests as feasible, including some on the computer.
6. Learn the directions for each section.
7. Learn how to recognize answers you can eliminate (Power of Elimination).
8. Train physically as well as mentally. You need to build up your back and neck muscles. Walk, jog, swim or lift weights (books or cans of food make good light weights).

Preparing for the Verbal Section of the GRE

The lowest initial GRE score for most science majors is the verbal score.
The score that requires the most extended time to improve is the verbal score.
Vocabulary is the heart of the verbal section, so…

1. Learn the most commonly encountered words

1. Review books have lists of "favorite words"
2. You will not be asked to give definitions of words. You will only need to know enough about a word to use it or eliminate it as a choice
3. Remember, some words have multiple uses
4. GRE likes unusual word uses; think outside the box

2. Learn root word, prefixes, suffixes to improve your ability to guess the meaning of unfamiliar words.

1. Many words are composed of syllables with general meanings.
2. Learn the connotation of words: knowing the emotional impact can often lead you to select or eliminate answers.
3. Many prefixes/suffixes have positive or negative connotations. Sometimes you only have to eliminate wrong connotations.
4. To decipher a word you don't know, look for… prefix, suffix, root word, context cues, relationship to another language.

3. Learn the relationships of words

1. Make "trees" of words with related meanings: synonyms, antonyms, or the same root.
2. GRE likes words that describe characteristics.

4. Make and use flash cards. Carry them with you!! It works!!!

Write a prompt word whose meaning you know on the note card. Write a line or two of words with similar meanings. Leave room to add new words. On a lower line or the back of the card, write antonyms of the prompt word.

One participant in the SMART GRE Prep Workshops increased her verbal score by 200 points by studying her flashcards 20 minutes a day, while she waited for and rode the bus.

5. Learn to speak "GREse"

Practice your new words in English with each other. Javier Sanchez would come to me each day and say a sentence using a new "GRE word" he had just learned. The sentence had nothing to do with our conversation, but he knew I was a safe person with whom to practice his "new language". He improved his English language skills and vocabulary significantly between the SMART program and starting graduate school. He won two fellowships to support his Ph.D. study at BCM.

6. Read at a more advanced level, dictionary in hand.

If your verbal score is below 400 we suggest that you consider reading the novel *Tooth and Nail* by Elster and Elliot. This novel was designed to help people improve their SAT verbal scores, but it works for improving verbal GRE scores. The novel highlights words that are likely to appear on the GRE and gives you context cues to their meaning. There is a glossary in the back with the definitions of the highlighted words. Students who have used this resource believed it helped them enhance their vocabulary. Then move onto more sophisticated literature. If you like novels like *Pride and Prejudice*, read them. Ok, you can watch the movie, too. Tom Clancey even uses some GRE type words in his novels. Isaac Asimov's original *Foundation* includes a page near the beginning filled with GRE type words.

I. Vocabulary Building for the GRE

MAKE AND USE FLASH CARDS:

Create flashcards listing a key word whose meaning you know, then add related words, including some you don't ordinarily use or even know when you start the list. List words that are different parts of speech from the key word. Index cards are a perfect size for flashcards and can be carried in a purse, pocket or backpack so that you can review them while you are waiting between classes, in lines or for a bus. When you make the cards, employ as many facets of learning as possible to make more mental connections between the words and cues to remembering them. Writing involves kinesthetic learning. Seeing the words involves visual learning, but if you say the words out loud you also activate auditory learning. If you say the words with an emotion that fits, you add an emotional cue to the word. Use position and color to help you remember meanings. Write words with positive connota-

tions in a color you like, and words with negative connotations in a color you don't like. The GRE loves to evaluate "degrees", especially in analogy questions. Write words that are "less than" the prompt word on the left side of the card and words that are "greater than" on the right. For example:

HASTY			
impetuously	quickly	accelerated	urgent

TREE RELATIONSHIPS go beyond synonyms or antonyms. Start with a common word you know and add related words. A thesaurus or even Google can be a great way to identify related words. Use the following examples for guidance:

STORE			
Synonyms/words that convey a similar idea:			
stock	reposit	accumulate	hoard
pantry	lode	vault	depository

Antonyms/words that convey an opposite idea:				
waste	consumption	deplete	exhaust	ephemeral

HASTY				
Related to similar meaning:				
quick	impetuous	accelerated	bustle	urgency
indeliberate	brusque	expedite	precipitate	

Related to opposite meaning:				
languish	dawdle	deliberate	lethargy	placid

LEARN PREFIXES, SUFFIXES, and ROOT WORDS

Many review books include a list of prefixes, suffixes and root words that are very helpful in deciphering words you encounter on the GRE. Even if you don't know the exact meaning of a word, you can often derive hints from knowing the general meaning of a syllable.

mis-	(wrong)	mistake, misplace, misappropriate, misconstrue
mal-	(bad)	maladjusted, malnourished, malfunction, maladroit
-less	(lacking)	helpless, fruitless, thankless, fetterless
sequ-	(follow)	sequence, sequel, subsequent, obsequious
strict-string	(bind)	strict, stricture, constrict, stringent, astringent

Building a Vocabulary that Opens Doors of Opportunity

One year, a participant in the SMART GRE Prep Workshops scored an almost perfect score on the verbal diagnostic test. What was more surprising was that he attended the workshops on building vocabulary, when he clearly didn't need to do so. During the group exercises, I noticed that he was providing very good advice to others in his small group on deciphering the meaning of words, in a very humble way. The other students had no idea how high his score was, they just recognized that he was helping them. When the session ended, I asked him why he had spent his time in a session he obviously didn't need to attend. His response was that he had no excuse for not scoring very high in the verbal section. He had attended a very challenging high school that was known for emphasizing vocabulary. But it was dinner conversations that made the most difference in building his extensive, sophisticated vocabulary. "Dr. Slaughter, my dad sounds like a GRE passage. I had to take a dictionary to the dinner table every night, because he would ask me questions with words I didn't know and wait for me to answer him. I can help other students develop their vocabulary, who haven't had my experiences." I was impressed. About a year later I saw his dad and related the story. He confirmed what his son told me. So I asked, "How did you develop your vocabulary? Did your father or mother teach you in the same way?" He laughed and said that no, his parents hadn't attended college and had a limited vocabulary. When he decided he wanted to pursue advanced education he had to learn new words the hard way. He didn't want his children to have to do what he did to score high enough on tests to be admitted to a school.

I tell this story at every verbal workshop and point out to students that they will be the ones who will teach their children, cousins, sisters and brothers, and friends new vocabulary through their own use of unfamiliar words within a context in which they can be understood. The dream of America is each generation passing along knowledge to the next to enhance opportunity so that people can reach their potential.

So what happened to our helpful SMART Program participant, Damon Tomlin? He became a BCM Ph.D. student and already has a first authorship on a high visibility paper published in a top science journal. We need to develop scientists and engineers from every group in America, and that includes white guys from affluent, educated households. Some of them are very talented and really nice.

II. Analogy Section (maybe eliminated in the future)

The GRE has included a section on analogies for many years. In October of 2006, the analogies section will be eliminated. ETS has provided limited information regarding the changes to the test as of October of 2005. Check the website for updates. The revised test will place greater emphasis on reading comprehension. If you have a choice about when to take the test, you may wish to consider this change in scheduling your exam date and take the test on which your skills are he strongest.

The task for the analogy section is to chose the pair of words that most closely match the relationship of the words in the given stem pair.

1. The only right answer will be the choice with a same type of clear and necessary relationship that matches the words in the stem pair.
2. The right answer must conform to the same parts of speech as in the stem pair, for example the only correct match to a stem with a noun: adjective is an answer with a noun:adjective format.
3. The correct answer must be in the same order as the words in the stem pair, for example, cause:effect will not match effect:cause.
4. You may need to evaluate the choice on more than one level to find the best match. The relationship of two choices may be correct but you need to consider other levels of comparison like the connotation or that the matched terms are related to weather or personal characteristics.

Strategies to improve your ability to answer analogy questions

1. Familiarize yourself with the types of analogies that you might encounter on the GRE.
2. Practice characterizing comparisons between words in the stem pair
3. Keep building your vocabulary
4. Practice analogy questions

A. Typical Analogy Relationships:

Opposites or synonyms

Opposites	abate : intensify
	accolade: criticism
	aggrandize: minimize
Synonyms	arduous: strenuous, taxing
	audacious: daring, bold

Action and activity

sob: sadness	action/meaning
run: marathoner	action/performer
lecture: class	action/recipient

Cause and effect

equivocate: confuse	exonerate: restore reputation

Specific and general

scientist: physicist	President: politician
drama: theatrical performance	

Parts and whole

lecture hall: university	island: archipelago
chapter: book	movement: concerto

Degrees

bold: audacious	speak: mumble
wind: hurricane	embarrass: mortify

Function

implore: convince	protection: refuge

Characteristics or conditions

oppress: subject	liberate: free
somber: cheer	honesty: reputable

Time or space

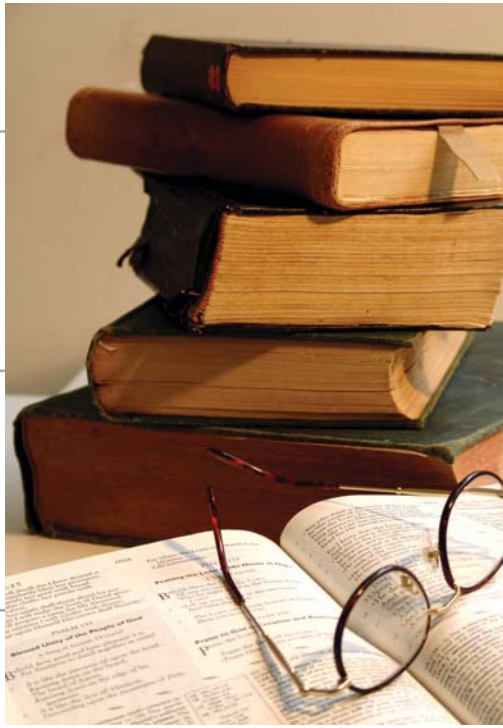
eon: moment	election: inauguration

B. Analogy Practice:

Choose the second pair of words that most clearly matches the relationship between the first pair.

1. teeth: comb

hair:brush
step:ladder
pulley:rope
picture:hook
door:library



2. sorrow:devastated

joy:happiness
sadness:glee
hunger:famished
glad:ecstatic
praise:laud

3. lecture:learn

assist:gain favor
criticize:denigrate
criticize:correct
information:confuse
traffic laws:issue tickets

4. university:school

book:library
jeweler:merchant
sculptor:artist
judge:lawyer
Nobel Prize:award

Analogy Practice Answers:

Choose the second pair of words that most closely matches the first pair of stem words.

		Explanations
1. teeth: comb		
	hair:brush	
→	**step:ladder**	**part vs. whole analogy**
	pulley:rope	
	picture:hook	
	door:library	
2. sorrow:devastated		
	joy:happiness	
	sadness:glee	
→	**hunger:famished**	**degrees analogy**
	glad:ecstatic	clues: part of speech
	praise:laud	
3. lecture:learn		
	assist:gain favor	
	criticize:denigrate	
→	**criticize:correct**	**function analogy**
	information:confuse	
	traffic laws:issue tickets	
4. university:school		double characterization
	book:library	**subset** or **type of entity,**
	jeweler:merchant	also a **degree comparison**
	sculptor:artist	
	judge:lawyer	
→	**Nobel Prize:award**	

Why bother to get comfortable using analogies?

Scientists and engineers often use analogies to explain unfamiliar terms or ideas to others. Many of your family members actually want to know what you do and need analogies to visualize complex situations. If you teach, you will find analo-

gies to be very helpful in explaining ideas to students. Analogies can be useful in describing your work in a grant proposal or to potential investors in your new device.

Who can forget the "kitchen sink" analogy used by Augusto Adone in the movie *Lorenzo's Oil,* as he and his wife Michaela tried to understand how the lack of an enzyme caused the myelin in Lorenzo's brain to deteriorate trapping their son inside his body? I tell students they really understand their projects when they can explain it to their grandparents. Of course it defeats the purpose of the "simplify the explanation" if the grandparent is Mattie Melnick or Rose Busch, who are accomplished scientists.

III. Sentence Completion

The goal of sentence completion questions is to find the best word or set of words that completes a sentence based on the context cues

Read the sentence and think of choices that make sense

The clues to finding the right word for sentence completion questions often involve identifying cue words that indicate whether you are looking for similar or different words

1. **Focus on signal or cue words**
   similiar: "and", "comparably", "likewise", "similarly", "therefore", "thus"
   → correct choice will be similar words
   contrasting: "although", "but", "despite", "however", "in contrast", "or", "on the other hand", "rather", "unfortunately", "unless", "while", "yet"
   → correct choice will be words that differ in meaning
   time frame: "afterward", "heretofore", "previously", "subsequently"
   versions of no: "no", "not", "not ever", "never", "under no circumstance"

2. **For two blank sentences you may need to start with one answer and see if it fits, then see if the other fits**
   Can eliminate some choices because one obviously doesn't fit
   May fill in the second blank first
   Careful, some choices make sense for one half of the sentence, but not the other

3. **Think about "good" versus "bad" words**
   Even if you don't remember the meaning of a word exactly, you may know if the word represents something good or bad
   The tone of the sentence will give you clues as to the right "emotion".

4. **If you don't know the meaning of some of the words,** eliminate any choices that you can; use prefixes, suffixes, root words for clues for other words.

IV. Reading Comprehension

Scientists must develop excellent reading skills. The reading comprehension portion of the GRE tests your ability to understand both short and long reading passages. The passage will appear on the screen. Every fifth line will be numbered, to provide you with an orientation to the passage. Some passages are longer than can fit on the screen, but you can scroll up and down. You can use the numbering effectively to guide you in jotting down key words or phrases on your scratch paper as you read the passage. Questions will be shown one at a time. Questions typically have five choices from which you select the best answer. You can move back and forth between the passage and the question section. The questions on your exam may ask you to identify the main idea, interpret the author's tone or opinion, provide factual information, or draw an inference from the passage or show other evidence that you understood the passage. Beginning in October, 2006 the GRE will place greater emphasis on reading comprehension and eliminate the analogy questions. Test takers will be asked to identify sentences in the passage that relate the same idea as a prompt statement. Check the GRE website for upcoming information.

A. EFFECTIVE READING FOR THE GRE

1. **Identify the main idea of the passage.**
   Almost every passage has a main idea. Keep the main idea of the passage in mind while reading or answering questions. **Wrong answers will often be inconsistent with the "big picture."**

2. **Recognize the sense of each paragraph.**
   Long passages are organized in paragraphs. Jot down phrases and a main idea for each paragraph on your scratch paper with a nearby line number denoted,

for example, "25 faunal migration" for information that starts on line 27 about faunal (animal) migration. If you need to refer back to the passage for details to answer a question, you will know how to find the information without rereading the entire passage. **Knowing the scope and tone of the work will allow you to eliminate answer choices that represent matters outside the spectrum of the passage.**

3. **Be an active reader.**
   Most of the time people read passively, that is they don't pay enough attention to grasp what they are reading. You must comprehend – not learn - what you are reading. **You must be a very active reader.** Think about what you are reading. Paraphrase confusing or complicated parts. Ask yourself questions as you are reading. When you do these things, you don't just absorb the passage, you attack it. Jot down what seem to be important points – often names - with a line number.

4. **Don't try to "learn" or remember the passage.**
   On standardized tests you only need to retain information long enough to answer the questions. Many of the details in the passage are completely unnecessary for answering the questions. **It is ineffective to read the passage for detail.** You can, and should, **go back to find the detailed information that is needed to answer a specific question.**

5. **Eliminate wrong answer choices.**
   You may need to use the process of elimination to determine the correct answer. There are usually **some answer choices that will be clearly wrong. Look for this type of choice, and eliminate it.** Pick the correct answer from the remaining choices. One of the best tools to use to eliminate wrong answers is to set up a grid or list on scratch paper where you can X out wrong answers and focus on the remaining choices. If you eliminate three choices, your increase your chances of picking the right one from 20% to 60%.

6. **Use the passage to direct your answers.**
   Everything that you need to answer the questions is provided by the passage. Be cautious in using outside knowledge. **The author of the passage may have a very different perspective from views with which you are familiar.** Remember many questions ask, "According to the author…"

EFFECTIVE USE OF SCRATCH PAPER FOR GRE READING COMPREHENSION

Test appearance

- The GRE reading sections will be passages of different length.
- Some will be too long for all of the passage to appear on the screen at once.
- You may have to scroll up and down on the screen the see parts of the passage.
- The questions will appear one at a time.

Making notes

- One of the biggest differences in taking the GRE on the computer is that you can't circle and underline important things on the reading passages, like people did in the paper test- so don't do it on practice exams.
- Each fifth line is numbered – so use this to your advantage. When you spot a word of phrase that seems important – jot down a reminder and a line number. You don't have to count and list the exact line number, just get close. For example, line 37 says, "Increased concentrations of greenhouse gases enhance greenhouse effect, trapping more heat near the Earth's surface." (from Princeton Cracking the GRE).
- Note could say: 35 greenhouse gas or even GH gas
- Maybe you want to list "25 A opin" (for the author's opinion of an article listed on line 27)
- You need just enough of a reminder to find something in a long paragraph.
- Working out a system of abbreviations and numbering ahead of time as you review material and take practice tests will be very valuable.

B. CHOOSING CORRECT ANSWERS TO READING COMPREHENSION QUESTIONS:

Here are some important tips to remember about the GRE:

1. The GRE doesn't use absolute statements, unless the question is an "According to the author or passage…".
2. None of the correct answers will mention points not relevant to the question.
3. None of the correct answers will raise a topic outside the scope of the passage.
4. None of the correct answers will be outrageous or have a tone not seen in the passage.
5. None of the correct answers will include extreme statements.

Therefore, eliminate any answer choice that:

1. makes absolute statements that use words like "always, never, under every circumstance", unless the question is an "According to the author" type.
2. mentions something you did not read in the passage.
3. is too detailed or specific, for general or inference questions.
4. uses extreme or overly emotional language.
5. misrepresents the information in the passage.
6. repeats a large portion of the passage.

THE QUANTITATIVE SECTION:

I. General Quantitative Pointers

The GRE tests very general math skills. You probably learned this math in high school. Most GRE math will be a review, but you may need to use review books to remind yourself or learn how to solve the problems encountered on the quantitative section of the GRE. Kaplan produces a Math Review that many of our students find helpful. A review group composed of people with different math strengths can be helpful in saving you time on acquiring pointers or the fastest way to approach problems. The timed nature of the GRE tests the ability to eliminate the wrong answers and identify the right answers quickly, not by brute force. In addition to questions that test algebra and geometry skills, problems will test logic skills. Many complex geometric figures can be broken down into simple figures with sides or angles that you can deduce from simple rules. Some problems will involve equations or numerical comparison. Some questions will involve "word" problems for which you will need to write equations and solve them to determine the right answer. Some questions involve interpretation of graphs or tables, skills often used by scientists and engineers. There are no questions that relate to calculus or trigonometry on the general GRE.

The Composition of the Quantitative Component is typically

- General Arithmetic: 1/3
- Algebra: 1/6
- Geometry: 1/3 (will be reduced in October, 2006)
- Graphs: 1/6
- Word problems make up one-quarter of the quantitative problems

Pointers for preparing for the Quantitative GRE Exam

1. **Review math symbols:** $=, \neq, <, >, \leq, \geq, \sum$
2. **Review math formulas.** Go over things like the area of a circle, the quadratic equation, the equation to determine the length of the hypotenuse. Flash cards are especially helpful for reviewing formulas.
3. **Review math operations** like multiplying, square roots, exponents, decimals, fractions, factoring, consecutive integers, positive X negative numbers , primes, etc.
4. **Review geometry:** triangles, comparing sides and angles; dissecting complex figures into simple forms where you can determine values.
5. **Memorize common values:** π (3.14 is close enough) square roots (up to 144), common triangle sides
6. Don't be panicked by **variables**, even strange ones with made-up definitions.
7. Learn to **approximate** without lengthy calculations.
   You can eliminate many answers immediately
   Use common sense; check the units.
   In the future, there will be a simple calculator on the computer that will be used to derive actual numbers for some questions.
8. Comparison questions all use the same form.
   You must compare the values in Column A and Column B.
   Column A is either equal to (=), less than (<), or greater than (>), column B, or the comparative value of A and B "cannot be determined" from the information given in the problem.
   The **answer cannot be "cannot be determined" if both sides contain known numbers** (square roots, may be positive or negative number).
9. **Always simplify;** this is sometimes all that is needed to determine the correct answer. Break down your computation into workable steps.
10. **Read the entire question,** especially word problems carefully before embarking on the math.
11. Don't assume the figures are drawn to scale unless specifically stated. **Draw!** A picture may be worth a thousand words.
12. You can **work backwards from the answer choices** if necessary. Try starting with the middle value. **Assign values** to variables if time allows.

II. Analyzing Charts and Graphs

This part of the exam tests your ability to interpret information displayed in graphs. Questions combine interpretation of text and figures. More than one graph or table may be required to answer a question. Sometime the figures cannot all be seen on the screen at the same time and you have to scroll up and down to see them. You may need to convert fractions to/from percentages (review this skill).

There are 3 basic kinds of graphs

1) Pie charts - used to represent the parts of a whole or %
2) Line graphs - used to represent mathematical relationships
3) Bar graphs - used to compare data

1. Pie charts- must add up to 100%

Questions usually involve the ratio of different groups
May involve percentages or fractions
May need to draw from information in a reading problem

2. Line graphs-have no lower or upper limit, although 0 is often, but not always, the start.

Check the **units** on both axes
Measurements may be **continuous or discontinuous**
Scales **may be linear,** but not guaranteed
Graphs **may not begin at 0;** only part of a range may be shown

3. Bar graphs (histograms)-used to compare groups to each other

Check **units** on both axes
Measurements may be **continuous or discontinuous**
Scales **may be linear,** but not guaranteed
Graphs may **not begin at 0;** only part of a range may be shown
Negative values may be used

You may **not see all of the graphs that relate to a question on the screen at the same time.** Scroll up or down to get to the "right" graph for the question.

Rely on the numbers if given, not the way the graph "looks" to you, but **sometimes** no exact number is provided and **you have to approximate a value by looking at the graph.** In these cases, the right answers are far enough apart that error in approximating the value shouldn't lead you to the wrong answer. You could even eliminate two answers that are so close together that approximation wouldn't work.

You do not need to do exact calculations to answer many questions. Practice manipulating approximate values, like 33% as 1/3 or 15% as 1/6.

III. Final Tips for the Quantitative Section

1. Always avoid unneeded, lengthy computations. Use approximations and logic.

2. When working with variables, remember that they can represent any number, unless otherwise stated, this includes fractions, decimals, zero, negative, and positive numbers. Don't get panicked if the variable are not a, b, x, or y.

3. Examine all the graphs and figures before working the problem. The answer may be made more obvious in the figures than in the text.

4. Examine the comparative nature of the two columns in comparison questions before doing the math. Often, the answer is obvious without a complicated computation.

5. Never guess "cannot be determined" in a comparison question unless the question contains variables or geometric figures or square roots.

6. Make sure your answer is in the requested units. Classic wrong answers list the correct numerical value, but in the wrong units.

7. Always make sure your answer choice is reasonable.

8. Check your math with the answer choices. If your answer isn't a choice, then you have made a miscalculation.

9. The incorrect answer choices are picked for a reason. They often represent the result of a possible error (decimal point) or misinterpretation of the question.

10. Don't presume that because you are a math minor you don't need to practice or even review material for the quantitative portion of the GRE. You probably haven't used some of the math skills since high school. A diagnostic test score will give you enough information to know how much effort you need to spend to get a good score on this part of the GRE.

THE ANALYTICAL WRITING SECTION

I. Description of the GRE Writing Assessment

What skills does it measure?

The GRE writing assessment gives you the opportunity to display critical thinking and analytical writing skills. It assesses your ability to articulate and support complex ideas, analyze an argument, and supply focused and coherent discussion. It is NOT a test of specific content knowledge, and there is no single best answer. For these reasons and because you will be developing your own well-reasoned responses rather than selecting answers from a multiple-choice list, the assessment provides very different information about your abilities than that provided by the General Test. Your writing is not expected to be a finished, polished essay. It is considered draft writing, where the ideas and how you present them are more important than perfect grammar.

The assessment consists of two analytical writing tasks:

1. "Present your Perspective on an Issue" task: 45-minutes

Currently, you are given a choice between two "Issue" topics. Each states an opinion on an issue of broad interest and asks you to discuss the issue from any perspective(s) you wish, as long as you provide **relevant reasons and examples to explain and support your views.**

This task requires you to construct you own argument by taking a position and providing evidence supporting your views on the issue.

Issue Topics: Relate to a broad range of subjects from the fine arts and humanities to the social and physical sciences. Issue topics are designed to elicit the kinds of complex thinking and persuasive writing that university faculty consider important for success in graduate school. No topic requires specific content knowledge.

In the future, it has been proposed that the GRE will not use pre-set prompts. You will be presented one prompt, so the time limit will be reduced to 30 minutes.

2. "Analyze an Argument" task: 30-minutes

You will **NOT** have a choice of "Argument" topics, but will instead be given an argument to analyze. The "Argument" task presents a different challenge from that of the "Issue" task. It requires you to critique a given argument by discussing how well reasoned you find the argument. You will need to consider the logical soundness of the argument based on the data given to support it rather than to agree or disagree with the position it presents.

This task requires you to critique someone else's argument by assessing its claims and evaluating the evidence it provides.

Argument Topics: are based on a range of familiar subjects and situations. No topic requires specific content knowledge.

The Published Pools of "Issue" and Argument Prompts

Everyone should spend some time preparing for the GRE Writing Assessment. Currently ETS publishes the entire pool of prompts used on the test. You might find it useful to review the entire Issue and Argument pools. You can download the published pool from the following web site: *www.gre.org/writing.html* or you can obtain a copy by writing to GRE Program, PO Box 6000, Princeton, NJ 08541-6000. Practice writing essays with a few prompts, but don't try to prepare an essay for every possible choice. You will get the hang of writing essays from practicing with a few topics.

Changes to how the prompts will be selected in the future will be announced on the GRE website. ETS may begin using a broader base of prompts to eliminate pre-prepared essays. ETS constantly struggles with people trying to find ways to cheat on their tests.

Scoring Guidelines for the Analytical Writing Section

The GRE writing assignments are graded on a 0-6 scale with 6 as the highest score. The scores are reported in 0.5 point increments. The scoring guidelines are provided on the GRE website.

II. STRATEGIES FOR THE "PRESENT YOUR PERSPECTIVE ON AN ISSUE" TASK

Understanding the "ISSUE" Task

This section of the test assesses your ability to think critically about a topic of general interest and to clearly express your thoughts about it in writing.

Each topic in this section makes a claim about an issue that test takers can discuss from various perspectives and apply to many different situations or conditions. Your job is to present a compelling case for your own position on the issue.

Read the topic carefully; Think about the claim from several points of view; make notes about the position you want to take; think of examples that you want to develop more fully in your essay. The examples can be from something you have read, learned in class or know from general knowledge.

It is important that you address the central issue; however, you are free to take any approach you wish. For example, you might:

- completely agree or disagree with the claim
- question the assumptions of the statement
- qualify any of its terms, especially if the way you define a term is important to developing your perspective on the issue
- point out why the claim is valid in some situations, but not in others
- evaluate points of view that contrast with your own perspective
- develop your position with reasons that are supported by several relevant examples or by a single extended example

Whatever position you take, you must make your position clear. Leaders must often analyze complex problems, so taking a position, but citing an alternate hypothesis or example of a situation that disagrees with your general position reflects your ability to think broadly. Be sure if you do this that you don't appear indecisive.

Understanding the Context for Writing: Purpose and Audience

This is an exercise in critical thinking and persuasive writing whose purpose is to see how well equipped you are to develop a compelling argument supporting your own perspective on an issue. Your audience consists of college and university faculty who are trained as GRE analytical writing readers.

Preparing for the "ISSUE" Task

You will need to know how to use reasons, evidence, and examples effectively to support your position on an issue.

1. Carefully read the prompt and make sure you understand the issues involved.

2. Think about the issue in relation to your own ideas, to what you have read, to people or facts you know. This is the knowledge base from which you will develop reasons and examples for your argument.

3. Decide what position on the issue you want to take and decide what compelling evidence (reasons and examples) you can use to support your position.

Have Fun Preparing for the "Present Your Perspective on an Issue" Task

Can you actually have fun preparing for the GRE? Yes, of course. If all depends on how you approach developing the skills and mindset to prepare for doing your best on the GRE, or anything else in life. The "Present Your Perspective on an Issue" task is a perfect example of how you can enjoy preparing for the GRE.

Print the list of prompts from the GRE website. Take them with you when you get together with friends who are preparing for the test. Discuss issues while you prepare or have dinner, go shopping, wait for the movie to start, drive to the club where you dance, jog or whatever you do for fun. Yes, you can talk about basketball scores or skirt lengths for a little while, but will those topics affect your future? Spending time sharing ideas and getting more comfortable with expressing your opinions may affect where you go to graduate school and your entire career. Invest your time as wisely as you will invest your money in the future.

Writing the "Present Your Perspective on an Issue" Essay

1. Take no more than 10 minutes to jot down a few notes to guide your writing.

2. Start writing your essay with a clear statement of your position.

3. Develop the examples to support your position. Use several examples or an extended example to support your position. Rearrange points to improve the logical flow. For example, don't place your alternative hypothesis or example in the middle of the points supporting your position.

4. Close with a summary statement that reinforces your position.

5. Use "GRE type vocabulary", when you can use sophisticated words properly. Don't just throw in words because they sound good. Never use a word in an essay if you are not sure of its meaning.

6. Be sure to allow at least 5 minutes to proof read your essay, substitute a more sophisticated term for a common word, add a transitional sentence or phrase.

III. STRATEGIES FOR THE "Analyze an Argument" TASK

Understanding the "ANALYZE AN ARGUMENT" Task

This section of the test assesses your ability to analyze and critique claims and to clearly express your thoughts about them in writing. The prompt will include data and conclusions. You are to present a compelling case for your own analysis of the claim, based on the data given and your assessment of its strengths and weaknesses.

Understanding the Context for Writing: Purpose and Audience

This is an exercise in critical thinking whose purpose is to see how well equipped you are to develop a compelling argument supporting your own criticism of someone else's claim. Your audience consists of college and university faculty who are trained as GRE analytical writing test readers.

Preparing for the "ANALYZE AN ARGUMENT" Task

1. Carefully read the claim and make sure you understand the evidence and conclusion(s). Conclusions may be preceded by words like however, thus, therefore, evidently, hence, in conclusion.

2. Make brief notes (only words or phrases) on your scratch paper about the points you will make in your essay.

3. Decide how strong you think the evidence is relative to the statements of the claim. Is the claim too global and overstated? Describe hypothetical situations or circumstances that were not considered. Are any statistics presented valid? Are there alternative explanations for the claim other than the evidence presented?

Writing the Essay for the "ANALYZE AN ARGUMENT" Task

This analysis is like reviewing a scientific paper, so the time you spend in developing this skill will be a good career investment.

1. **State your position clearly.** It is unlikely that you will completely agree with the claim. It is your job to find flaws in the claim. Discuss the logical soundness of the author's case. Raise issues that you believe were not considered in making the claim. Discuss alternative explanations. Point out illogical conclusions.
2. **Do not** confuse this assignment with the "Present a Perspective" task. Do not discuss whether you agree or disagree with the position. Address whether the evidence presented supports the claim adequately. Do not express your own personal views.

Psyching-Up to Succeed on the GRE or at Anything

1. Remember you are in training for the mental Olympics.
   Start, or continue, eating a **healthy diet**; limit the sugar
   Strengthen your stamina, back and neck muscles
   Swim or jog or walk; lift light weights, if possible

2. **Assess your mental frame of mind during test taking**
   Think back to your practice exams, the SAT, class exams
   Do you get nervous or do you start depressed and paralyzed?
   Nervous reactions: heart is racing; dry mouth; jittery; sick at stomach; jump around from one question to the next; trouble concentrating on a question
   Paralytic reactions: frozen; slow start; doubts about ability; uncertain about answers; can't make up your mind

Learn to **alter your mental attitude;** experiment with mental images; find those that work; practice them. If you start practicing visualizing your images for 20 minutes a day, you will reach the point at which you can slip into a productive frame of mind in seconds. Your goal is not to go to sleep, at least not while you're taking the GRE, but to relax enough to concentrate. Old calendars are great visual cues when you start testing and practicing images. They're really cheap at the end of a year.

Strategies to combat nervousness:

Think about calm peaceful environments (forest; mountains; seashore)
Zen out before you start (meditate; pray; remember positive thoughts)
Imagine working at a steady productive pace
Feel your heart slow down; breathing deepen; muscles relax; sense of calm

Strategies to combat paralysis:

Psyche yourself or hit the caffeine, if it doesn't cause bad side effects
Imagine a great success; pick a mental image that works
Imagine you are participating in an exhilarating sport (skiing, sailing or anything else that works, but doesn't distract you). Feel the blood rushing through your veins; your breathing strengthen; an energetic feeling coursing through your body. Great tactic to use when you are exhausted from attending an undergraduate research conference.

3. **Final preparation**

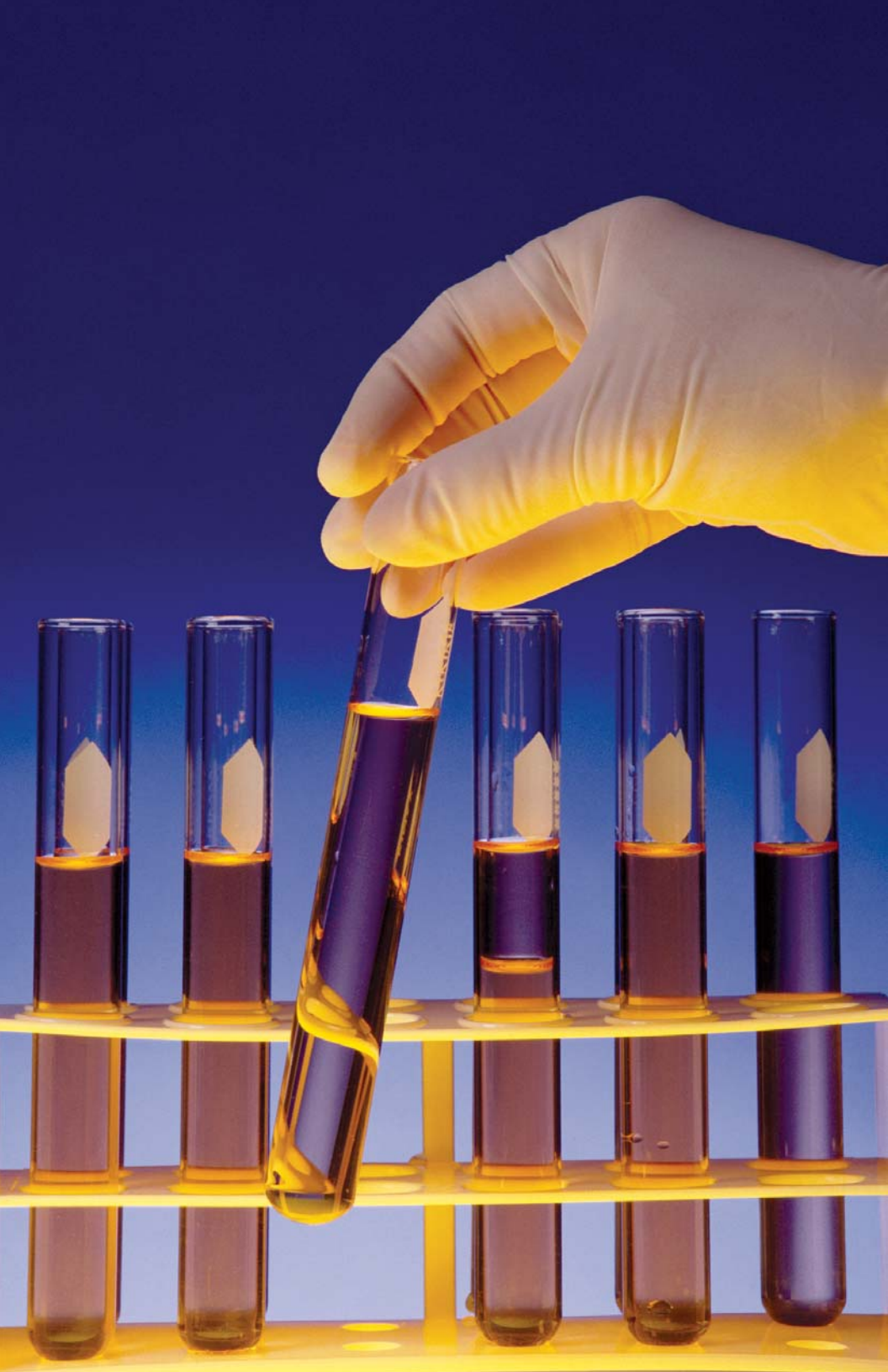
A week before the exam

Review flashcards of math formulas and vocabulary
Review as many vocabulary lists as possible; practice quantitative problems
Take a practice test on the computer, if possible, including writing essays
Find your test site

Night before and day of the exam

Review directions for all sections, if necessary
Try to get a good night's sleep before the test
Eat what works for you: meal; carbohydrates; bring change or a snack
Dress comfortably (layers are good for temperature control)
Remember to go to the bathroom before you start the test
Arrive early; get scratch paper; **write anything you want on scratch paper**
Do your own personal mental attitude check; slip into your mental routine

Remember you prepared for this- you deserve to do well and achieve your dreams!



Chapter Three: Enhancing Logical Thinking Skills

Our original SMART GRE Prep Workshops included sessions on solving deductive reasoning problems like those presented in the analytical portion of the GRE. This section of the exam was eliminated in 2002, but students felt the skills they developed solving the problems were very valuable. We have included a set of logic problems that many people will find interesting and have fun solving while they enhance their deductive reasoning skills. Some of the problems may seem hard at first, but our students found that with a little perseverance and sometimes checking the strategies given at the end of problems, they deduced answers faster and faster. Have fun!

TOP-RANKED STUDENTS

Six students, Anjelica, Michael, Leticia, Whitecloud, Raymond and Jonathan, are the top six ranking students (not necessarily in order) in their graduating class. Each of the six students has a different major – Biology, Chemistry, Mathematics, Physics, Psychology or Architecture. Based on the following clues, please answer the 5 questions below.

Clues:

1. The 3rd ranked person is a woman and did NOT major in Psychology.

2. Leticia ranked higher than Jonathan, who ranked higher than Michael.

3. The person who majored in Architecture ranked one higher than the person who majored in Psychology and one lower than the person who majored in Chemistry.

Questions:

1. If Whitecloud ranked 2nd, her major could NOT be which of the following:
   a. Biology
   b. Chemistry
   c. Mathematics
   d. Physics
   e. Architecture

2. Which of the following is an acceptable order of rank (from 1st to 6th)?
   a. Leticia, Whitecloud, Jonathan, Raymond, Michael, Anjelica
   b. Whitecloud, Michael, Leticia, Raymond, Jonathan, Anjelica
   c. Raymond, Leticia, Anjelica, Jonathan, Whitecloud, Michael
   d. Anjelica, Jonathan, Whitecloud, Leticia, Raymond, Michael
   e. Leticia, Raymond, Jonathan, Anjelica, Michael, Whitecloud

3. If Anjelica ranks 4th and Leticia does NOT rank 1st, then Jonathan must rank:
   a. 1st
   b. 2nd
   c. 3rd
   d. 5th
   e. 6th

4. If Anjelica ranks 4th and majors in Psychology, and Jonathan's major is Chemistry, then Leticia must rank:
   a. 1st
   b. 2nd
   c. 3rd
   d. 5th
   e. 6th

5. If Whitecloud ranks 4th, and Michael does NOT rank last, than Michael could major in any of the following EXCEPT:
   a. Biology
   b. Chemistry
   c. Mathematics
   d. Physics
   e. Architecture

Answer Key:

TOP-RANKED STUDENTS

1. E
2. C
3. D
4. A
5. B

Answer Key with Explanations:

TOP-RANKED STUDENTS

1. **E**

   Explanation: E is the correct answer. Architecture could NOT be Whitecloud's major if she were ranked 2nd for the following reasons: Clue 3 tells us that the Architecture is ranked one higher than the Psychology major and Clue 1 says that the 3rd ranked person did NOT major in Psychology. Therefore, the 2nd ranked person, who is Whitecloud, cannot major in Architecture.

2. **C**

   Explanation: Neither A) nor E) can be the correct answer because the 3rd ranked person has to be a women (Clue 1). Both options A) and E) have a male ranked 3rd. Neither B) nor D) can be the correct answer because Leticia is ranked higher than Jonathan, who ranked higher than Michael (Clue 2), and the order of rank in both B) and E) violate this rule. C) is the correct answer because it does not violate any of the three clues.

3. **D**

   Explanation: We are told that Anjelica ranks 4th and Leticia does NOT rank 1st. Given this, we are asked to rank Jonathan. A) is not correct. Jonathan cannot rank 1st because clue 1 states that Leticia ranks higher than Jonathan. B) is not correct. Jonathan cannot rank 2nd because Leticia NOT ranking 1st (given in question) will not allow Leticia to rank higher than Jonathan (Clue 2). C) is not correct. The person ranked 3rd has to be a women (Clue 1). E) is not correct. Jonathan cannot rank 6th because Michael has to rank lower than Jonathan (Clue 2) and 6th is the lowest ranking given in the problem. D) is the correct answer. Jonathan must rank 5th in order not to violate any of the given clues.

4. **A**

   Explanation: We are told that Anjelica ranks 4th and majors in Psychology, and Jonathan's major is Chemistry. We are asked what Leticia must rank. If the 4th ranked person's major is Psychology (given) then the 3rd ranked person's major must be Architecture and the 2nd ranked person's major must be Chemistry (Clue 3). This would rank Jonathan 2nd, since we are told that his major is Chemistry. Given this, Leticia must rank 1st because Clue 2 tells us that Leticia ranks higher than Jonathan. So A) is the correct answer. B) is not correct. Leticia cannot rank 2nd because Jonathan ranks 2nd, based on the above. C), D) and E) are not correct because Leticia cannot be ranked lower than Jonathan (Clue 2).

5. B

Explanation: We are told that Whitecloud ranks 4th, and Michael does NOT rank last. We are asked which major Michael could NOT be. Clue 2 tells us that Michael is two ranks below Leticia, meaning that Michael cannot be 3rd . By the information given in the question, Michael is not 4th or 6th so he is most likely 5th. By Clue 3 we know that the Chemistry major is above Architecture and Psychology and since there are only 6 students, placing Michael 5th would mean that he cannot be the Chemistry major.

SUITEMATES

The program director of a summer research program must place four program participants into two suites in the dorm: suite number 201 and suite number 202, each of which contains a room A and a room B. The four girls, Natalie Khan, Tanisha Thompson, Rene Eaglefeather and Vanessa Salazar, are each majoring in a different field (Neuroscience, Biochemistry, Economics, and Bioengineering). They are each funded by a different source: The National Science Foundation (NSF), The National Heart Lung and Blood Institute (NHLB), The Department of Defense (DOD) or the student's mentor. Using the following clues, answer the questions below.

Clues:

1. Rene Eaglefeather is neither the Neuroscience major, nor is she funded by the DOD.
2. Neither Vanessa Salazar, nor the girl in 201A is funded by NSF or is an economics major.
3. The girl in 201B is not the Neuroscience major.
4. Natalie Khan is not in 201A or 202A.
5. The girl funded by NHLB is neither the Neuroscience nor the Bioengineering major.
6. Tanisha Thompson is not in 202B.

Questions:

1. Rene Eaglefeather is funded by which of the following sources?
   a. Mentor b. NSF c. NHLB d. DOD

2. Natalie Khan is sharing a suite with the girl majoring in what field?
   a. Biochemistry b. Neuroscience c. Bioengineering d. Economics

3. The student funded by the Department of Defense is sharing a suite with which girl?
   a. Rene Eaglefeather b. Vanessa Salazar c. Natalie Khan d. Tanisha Thompson

4. The student majoring in Bioengineering is living in which room?

a. 201A b. 201B c. 202A d. 202B

Suitemates	201A	201B	202A	202B	Neuroscience	Biochemistry	Economics	Bioengineering	NSF	NHLB	DOD	Mentor
Natalie Khan												
Tanisha Thompson												
Rene Eaglefeather												
Vanessa Salazar												
NSF												
NHLB												
DOD												
Mentor												
Neuroscience												
Biochemistry												
Economics												
Bioengineering												

Using this table you can correctly answer all of the questions asked in this problem. Answers on page 52.

ROADTRIP

Five students in a summer biomedical sciences research program have become fast friends and have decided to take a weekend road-trip to New Braunfels to go tubing down the Guadalupe River. Each student comes from a different part of the country, (a small coal mining town in Pennsylvania; a newly developed neighborhood in Reno, Nevada; a cattle ranching community in West Texas; an inner-city neighborhood in Chicago and an affluent gated community outside of Dallas) and they each major in different fields, (philosophy, molecular biology, pre-medicine, engineering, and psychology). The morning of the road-trip, each student boarded the car at a different time: 8:00, 8:05, 8:10, 8:15 and 8:20. Using the following clues as guidance, answer the questions below.

Clues:

1. Gloria Campbell boarded sometime after the student from Nevada and just before the engineering major.

2. The five students are: the pre-medical major, the student from Chicago, the student that boarded at 8:10, the molecular biology major and the student that boarded at 8:15.
3. The student from Pennsylvania boarded just before the pre-medical student.
4. Shanda Morris, who is not the psychology major, boarded at 8:10.
5. Meredith Wong boarded just before the psychology major (who didn't board at 8:20).
6. The student from West Texas is neither Shanda Morris nor Mario Valdez, nor is this student the pre-medicine major.

Questions:

1. Which student is from Pennsylvania?
   a. Mario Valdez b. Gloria Campbell c. Shanda Morris
   d. Dale Atkus e. Meredith Wong

2. The student that boarded at 8:15 is majoring in which field?
   a. Philosophy b. Psychology c. Pre-Medicine
   d. Engineering e. Molecular Biology

3. Mario Valdez is from which part of the country?
   a. Nevada b. Dallas c. Chicago
   d. West Texas e. Pennsylvania

4. At what time did Gloria Campbell board the car?
   a. 8:00 b. 8:05 c. 8:10 d. 8:15 e. 8:20

5. The student from Nevada is majoring in which field?
   a. Pre-Medicine b. Psychology c. Engineering
   d. Molecular Biology e. Philosophy

TRICK-OR-TREAT

Five girls dressed up and trick-or-treated for Halloween (Jessica, Sophia, Isadora, Glendaliz and Nisha). Each of them wore a different costume (Firefighter, Veterinarian, Astronaut, Olympic ice skater or Ballerina), is a different age (3, 4, 5, 6 or 7) and went out trick-or-treating at a different time on Halloween (7:30pm, 7:45pm, 8:00pm, 8:15pm, 8:30pm). Based on the following clues, please answer the 6 questions below.

Clues:

1. The girl who dressed as an Olympic ice skater, who is not Sophia, is older than Nisha and went out before the girl who is 5 years old, who did not dress as a Firefighter.
2. Isadora, who did not dress as a Astronaut, is younger than the girl who dressed as a Ballerina but older that the girl who went out at 7:45pm, who did not dress up as a Veterinarian.
3. Jessica, who is not 6 years old, went out 30 minutes after the girl that is 4 years old but 15 minutes before the girl who dressed as a Firefighter.
4. Glendaliz dressed as a Veterinarian and went out 30 minutes before Sophia but after the girl who dressed as an Astronaut.

Questions:

1. What did the girl who went out at 8:15pm dress as?

   a. Firefighter b. Veterinarian c. Astronaut
   d. Olympic ice skater e. Ballerina

2. At what time did the 7 year-old trick-or-treat?

   a. 7:30pm b. 7:45pm c. 8:00pm d. 8:15pm e. 8:30pm

3. What did the 4 year old girl dress up as?

   a. Firefighter b. Veterinarian c. Astronaut
   d. Olympic ice skater e. Ballerina

4. Who dressed as a Firefighter?

   a. Jessica b. Sophia c. Isadora d. Glendaliz e. Nisha

5. When did the 3 year-old girl trick-or-treat?

   a. 7:30pm b. 7:45pm c. 8:00pm d. 8:15p e. 8:30pm

6. When did the Olympic Ice-Skater trick-or-treat?

   a. 7:30pm b. 7:45pm c. 8:00pm d. 8:15pm e. 8:30pm

Trick-or-Treat

		Costume					Age					Time Trick-or-Treated				
		Firefighter	Veterinarian	Astronaut	Olympic ice skater	Ballerina	3	4	5	6	7	7:30pm	7:45pm	8:00pm	8:15pm	8:30pm
Name	Jessica															
	Sophia															
	Isadora															
	Glendaliz															
	Nisha															
Time Trick-or-Treated	7:30pm															
	7:45pm															
	8:00pm															
	8:15pm															
	8:30pm															
Age	3															
	4															
	5															
	6															
	7															

Using this table you can correctly answer all of the questions asked in this problem. Answers on page 54.

US AIR FORCE

John Haikawa, Keisha Washington, Anjelica Torres, Rollin Strack and Peter Doerre are in the United States Air Force. Each of them has a different rank (General, Lieutenant, Colonel, Sergeant or Major), a different amount of time in the service (10, 15, 20, 25 or 30 years) and flies a different aircraft (B-1, B-2, B-52, F-16 or C-17). Based on the following clues, please answer the 8 questions below.

Clues:

1. The General, who does not fly the B-52, has been in the Air Force 5 years longer than John Haikawa but 5 years less than the person who flies the F-16.
2. Anjelica Torres, who does not fly the B-2, has been in the Air Force 10 years longer than the Major.
3. Keisha Washington has less experience than the lieutenant.
4. The person who flies the C-17, who is not Peter Doerre, has 10 years less service than the Colonel but 5 years more service than the Major.
5. Rollin Strack flies the F-16.

6. The person with 20 years of service in the Air Force, who is not Keisha Washington, does not fly the C-17 and has more service than the Sergeant, who does not fly the F-16.
7. The person who flies the B-52 has less experience than John Haikawa.

Questions:

1. What rank is Anjelica Torres?
   a. General b. Lieutenant c. Colonel d. Sergeant e. Major
2. What does Keisha Washington fly?
   a. B-1 b. B-2 c. B-52 d. F-16 e. C-1
3. Who has 30 years of service in the airforce?
   a. General b. Lieutenant c. Colonel d. Sergeant e. Major
4. What aircraft does the person with 25 years of service fly?
   a. B-1 b. B-2 c. B-52 d. F-16 e. C-17
5. How many years of service does the Sergeant have?
   a. 10 b. 15 c. 20 d. 25 e. 30
6. Who flies the C-17?
   a. John Haikawa b. Keisha Washington c. Anjelica Torresd
   d. Rollin Strack e. Peter Doerre
7. Who flies the B-2?
   a. General b. Lieutenant c. Colonel d. Sergeant e. Major
8. How many years of service does the person who flies the B-52 have?
   a.10 b. 15 c. 20 d. 25 e. 30

WAITSTAFF

Andrew, Tula, Randall, Heidi and Phoung are all waiters at different restaurants (Olive Garden, Carraba's, Outback Steakhouse, Chili's or Hunan's). They are each working on a different day next week (Monday – Friday) and are working a different shift (10am-2pm, 10am-4pm, 11am-4pm, 12pm-7pm or 12pm-8pm). Based on the following clues, please answer the 6 questions on the following page.

Clues:

1. The person who works on Tuesday, who is not Randall, has a shift that starts later than the man who works at Outback Steakhouse, and has a shift that is shorter than Tula's.

2. Andrew, who does not work on Tuesday, works a day earlier than the person whose shift starts at 11am, who does not work at Chili's, but one day after the woman who works at Carraba's, whose shift is not 6 hours long.
3. Heidi, who does not work at Chili's, has a shift that starts earlier and lasts longer than the person that works at the Olive Garden, who does not work on Tuesday.

Questions:

1. Where does the person whose shift is 12pm-8pm work?
   a. Olive Garden b. Carraba's c. Outback Steakhouse
   d. Chili's e. Hunan's

2. The person who works on Friday has a shift that is how many hours long?
   a. 4 b. 5 c. 6 d. 7 e. 8

3. Who works at Hunan's?
   a. Andrew b. Tula c. Randall d. Heidi e. Phoung

4. On what day does the person whose shift is 7 hours long work?
   a. Monday b. Tuesday c. Wednesday d. Thursday e. Friday

5. Where does the person who works the day before Randall work?
   a. Olive Garden b. Carraba's c. Outback Steakhouse
   d. Chili's e. Hunan's

6. The person who works on Monday has a shift that is how many hours long?
   a. 4 b. 5 c. 6 d. 7 e. 8

Waitstaff

		Restaurant					Shift					Day Working				
		Olive Garden	Carraba's	Outback Steakhouse	Chili's	Hunan's	10am-2pm	10am-4pm	11am-4pm	12pm-7pm	12pm-8pm	Monday	Tuesday	Wednesday	Thursday	Friday
Name	Andrew															
	Tula															
	Randall															
	Heidi															
	Phoung															
Day Working	Monday															
	Tuesday															
	Wednesday															
	Thursday															
	Friday															
Shift	10am-2pm															
	10am-4pm															
	11am-4pm															
	12pm-7pm															
	12-pm-8pm															

Using this table you can correctly answer all of the questions asked in this problem. Answers on page 56.

SUNSET TRAIL

Audrey Beal, Juanita Mendez, Justin Chen, Michael Leiskau and Lorraine Patel all live on Sunset Trail in the Creekwood Park neighborhood. Each resident has a different career (engineer, chemist, university math professor, computer programmer and virologist). Each of their homes is painted a different color (taupe, mustard, periwinkle, charcoal or sea green) and has an address ranging from 500 to 504. All of the houses are on the same side of the street. If you drive from the 500 house to the 504 house, you are traveling south. With the following clues as guidance, please answer the 7 questions below.

Clues:

1. Audrey Beal, whose next door neighbor to the south is a university math professor, also lives south of Justin Chen, whose house is not periwinkle.

2. Michael Lieskau, who is not a computer programmer, is the southern neighbor of the resident of the taupe house.
3. The northern most house on the block is periwinkle, and is 2 doors away from the home of the virologist.
4. Lorraine Patel, whose house is not sea green, lives right in the middle of the block.
5. The resident with the taupe house, who is an engineer, is neighbors with Lorraine Patel.
6. The computer programmer does not live in the charcoal house next door to Juanita Mendez.
7. The sea green house is south of the mustard house next to where the chemist lives.

Questions:

1. At what address does Audrey Beal live?
   a) 500 Sunset Trail b) 501 Sunset Trail c) 502 Sunset Trail
   d) 503 Sunset Trail e) 504 Sunset Trail

2. What is the profession of the resident of the charcoal house?
   a) computer programmer b) engineer c) virologist
   d) university math professor e) chemist

3. Who is the computer programmer?
   a) Audrey Beal b) Juanita Mendez c) Justin Chen
   d) Michael Leiskau e) Lorraine Patel

4. What color is the virologist's house?
   a) taupe b) mustard c) periwinkle
   d) charcoal e) sea green

5. Who is the resident of 504 Sunset Trail?
   a) Audrey Beal b) Juanita Mendez c) Justin Chen
   d) Michael Leiskau e) Lorraine Patel

6. What color is Juanita Mendez's house?
   a) taupe b) mustard c) periwinkle
   d) charcoal e) sea green

7. What is Michael Leiskau's profession?
   a) computer programmer b) engineer c) virologist
   d) university math professor e) chemist

Sunset Trail

		Family's Last Name					Occupation					House Color				
		The Beal's	The Mendez's	The Chen's	The Leiskau's	The Patel's	Engineer	Chemist	Math Professor	Computer Prog	Virologist	taupe	mustard	periwinkle	charcoal	sea green
Address	500															
	501															
	502															
	503															
	504															
House Color	taupe															
	mustard															
	periwinkle															
	charcoal															
	sea green															
Occupation	Engineer															
	Chemist															
	Math Professor															
	Computer Progammer															
	Virologist															

Using this table you can correctly answer all of the questions asked in this problem. Answers on page 57.

SUITEMATES

Answer Key:

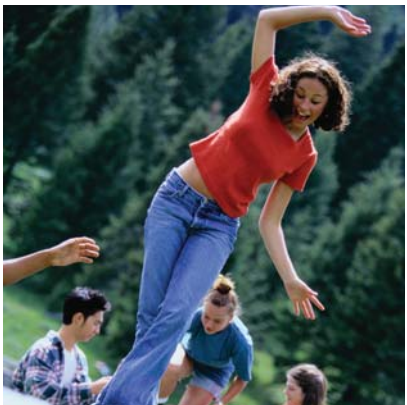
1. C 2. A 3. D 4. C

Answer Key with Explanation: SUITEMATES

If you worked the problem correctly, you should have determined the following things:

Student Name Room	Major	Funding Source	
Rene Eaglefeather 201A	Biochemistry	NHLB	
Natalie Khan 201B	Economics	Mentor	
Vanessa Salazar 202A	Bioengineering	DOD	
Tanisha Thompson 202B	Neuroscience	NSF	

Suitemates	201A	201B	202A	202B	Neuroscience	Biochemistry	Economics	Bioengineering	NSF	NHLB	DOD	Mentor
Natalie Khan	×	·	×	×	×	×	·	×	×	×	x	·
Tanisha Thompson	×	×	×	·	·	×	×	×	·	×	x	x
Rene Eaglefeather	·	×	×	×	×	·	×	×	×	·	x	x
Vanessa Salazar	×	×	·	×	×	×	x	·	x	x	·	x
NSF	×	×	×	·	·	×	x	x				
NHLB	·	×	×	×	×	·	x	x				
DOD	×	×	·	×	×	×	x	·				
Mentor	×	·	×	×	×	×	·	x				
Neuroscience	×	×	×	·								
Biochemistry	·	×	×	×								
Economics	×	·	×	×								
Bioengineering	x	x	·	×								



ROAD TRIP

Answer Key

1. C 2. A 3. B 4. B 5. D

Names	Region	Major	Time
Mario Valdez	Dallas	Pre-Medicine	8:20
Gloria Campbell	Chicago	Psychology	8:05
Shanda Morris	Pennsylvania	Engineering	8:10
Dale Atkus	West Texas	Philosophy	8:15
Meredith Wong	Nevada	Molecular Biology	8:00

TRICK-OR-TREAT

Answer Key:

1. E 2. D 3. C 4. B 5. E

Answer Key with Explanation: TRICK-OR-TREAT

If you worked the problem correctly, you should have determined the following things:

Jessica	Ballerina	7	8:15pm
Sophia	Firefighter	3	8:30pm
Isadora	Olympic ice skater	6	7:30pm
Glendaliz	Veterinarian	5	8:00pm
Nisha	Astronaut	4	7:45pm

Trick-or-Treat

		Costume					Age					Time Trick-or-Treated				
		Firefighter	Veterinarian	Astronaut	Olympic ice skater	Ballerina	3	4	5	6	7	7:30pm	7:45pm	8:00pm	8:15pm	8:30pm
Name	Jessica	×	×	×	×	·	×	×	×	×	·	×	×	×	·	×
	Sophia	·	×	×	×	×	·	×	×	×	×	×	×	×	×	·
	Isadora	×	×	×	·	×	×	×	×	·	×	·	×	×	×	×
	Glendaliz	×	·	×	×	×	×	×	·	×	×	×	×	·	×	×
	Nisha	×	×	·	×	×	×	·	×	×	×	×	·	×	×	×
Time Trick-or-Treated	7:30pm	×	×	×	·	×	×	×	×	·	×					
	7:45pm	×	×	·	×	×	×	·	×	×	×					
	8:00pm	×	·	×	×	×	×	×	·	×	×					
	8:15pm	×	×	×	×	·	×	×	×	×	·					
	8:30pm	·	×	×	×	×	·	×	×	×	×					
Age	3	·	×	×	×	×										
	4	×	×	·	×	×										
	5	×	·	×	×	×										
	6	×	×	×	·	×										
	7	×	×	×	×	·										

AIR FORCE

Answer Key:

1. A 2. C 3. B 4. D 5. B 6. A 7. B 8. A

Answer Key with Explanation: US AIR FORCE

If you worked the problem correctly, you should have determined the following things:

John Haikawa	Seargent	C-17	15
Keisha Washington	Major	B-52	10
Anjelica Torres	General	B-1	20
Rollin Strack	Colonel	F-16	25
Peter Doerre	Leutinent	B-2	30

WAITSTAFF

Answer Key:

1. B 2.B 3. D 4. B 5. C 6. C

Answer Key with Explanation: WAITSTAFF

If you worked this problem correctly, you should have determined the following things:

Andrew	Outback Steakhouse	10am-2pm (4hr.)	Thursday
Tula	Carraba' s	12pm-8pm (8hr.)	Wednesday
Randall	Olive Garden	11am-4pm (5hr.)	Friday
Heidi	Hunan's	10am-4pm (6hr.)	Monday
Phoung	Chili's	12pm-7pm (7hr)	Tuesday

Waitstaff

		Restaurant					Shift					Day Working				
		Olive Garden	Carraba's	Outback Steakhouse	Chili's	Hunan's	10am-2pm	10am-4pm	11am-4pm	12pm-7pm	12pm-8pm	Monday	Tuesday	Wednesday	Thursday	Friday
Name	Andrew	×	×	·	×	×	·	×	×	×	×	×	×	×	·	×
	Tula	×	·	×	×	×	×	×	×	×	·	×	×	·	×	×
	Randall	·	×	×	×	×	×	×	·	×	×	×	×	×	×	·
	Heidi	×	×	×	×	·	×	·	×	×	×	·	×	×	×	×
	Phoung	×	×	×	·	×	×	×	×	·	×	×	·	×	×	×
Day Working	Monday	×	×	×	×	·	×	·	×	×	×					
	Tuesday	×	×	×	·	×	×	×	×	·	×					
	Wednesday	×	·	×	×	×	×	×	×	×	·					
	Thursday	×	×	·	×	×	·	×	×	×	×					
	Friday	·	×	×	×	×	×	×	·	×	×					
Shift	10am-2pm	×	×	·	×	×										
	10am-4pm	×	×	×	×	·										
	11am-4pm	·	×	×	×	×										
	12pm-7pm	×	×	×	·	×										
	12-pm-8pm	×	·	×	×	×										

SUNSET TRAIL

Answer Key

1. D 2. E 3. B 4. B 5. D 6. C 7. D

Answer Key with Explanation: SUNSET TRAIL

If you worked the problem correctly, you should have determined the following things:

Address	Resident	House Color	Profession
500	Juanita Mendez	Periwinkle	Computer Programmer
501	Justin Chen	Charcoal	Chemist
502	Lorraine Patel	Mustard	Virologist
503	Audrey Beale	Taupe	Engineer
504	Michael Leiskau	Sea Green	University Math Prof.

Sunset Trail

		Family's Last Name					Occupation					House Color				
		The Beal's	The Mendez's	The Chen's	The Leiskau's	The Patel's	Engineer	Chemist	Math Professor	Computer Prog	Virologist	taupe	mustard	periwinkle	charcoal	sea green
Address	500	×	·	×	×	×	×	×	×	·	×	×	×	·	×	×
	501	×	×	·	×	×	×	·	×	×	×	×	×	×	·	×
	502	×	×	×	×	·	×	×	×	×	·	×	·	×	×	×
	503	·	×	×	×	×	·	×	×	×	×	·	×	×	×	×
	504	×	×	×	·	×	×	×	·	×	×	×	×	×	×	·
House Color	taupe	·	×	×	×	×	·	×	×	×	×					
	mustard	×	×	×	×	·	×	×	×	×	·					
	periwinkle	×	·	×	×	×	×	×	×	·	×					
	charcoal	×	×	·	×	×	×	·	×	×	×					
	sea green	×	×	×	·	×	×	×	·	×	×					
Occupation	Engineer	·	×	×	×	×										
	Chemist	×	×	·	×	×										
	Math Professor	×	×	×	·	×										
	Computer Progammer	×	·	×	×	×										
	Virologist	×	×	×	×	·										

Chapter Four: Making the Most of Mentor Relationships

Science is taught through an apprenticeship model

A mentor is an experienced person who takes an interest in and provides advice to someone who is establishing or progressing through a career. As a maturing scientist/engineer, you will want to seriously consider seeking mentor/mentee relationships with professionals you trust and from whom you can learn. The difference between being an advisor and a mentor is the level of personal interest a mentor takes in your life. While a mentor can be a sounding board for ideas, he or she should not dictate your actions. A good mentor should care enough to be honest about situations and help you arrive at plans of action that will promote your career and educational goals.

Understanding what type of mentorship you need:

1. As an undergraduate, you may seek a more **general mentor** relationship with someone who can provide you not only with direction and information about courses, graduate schools, careers, research opportunities and other science-related topics, but also personal advice for questions you might have related to life as a scientist/engineer. Depending on how well you work with your mentor, this person might end up writing you a letter of recommendation, or being someone with whom you do research.

2. A **professional advisor** may be someone that you will seek specifically for research and career development advice, but not for personal advice.

3. Undergraduates may have a series of **research mentors,** because some of their experiences are short term and last only a summer or semester. In some cases, you may be matched to a mentor by a program director. It helps your mentor if you provide information regarding your background in writing. Optimize the time you spend with the mentor so that he/she will feel that they know you. Sometimes heads of labs will communicate with a graduate student or post-doctoral fellow who supervises you on a daily basis. Letters of recommendation may be signed by both people.

4. As an undergraduate you can start to be observant about the qualities you would look for in a dissertation advisor, who provides research opportunities and guides you through the process of writing your Ph.D. dissertation and manuscripts describing your work. This advisor is someone with whom you will have frequent contact because you will need a lot of advice to learn to be an excellent scientist and produce a high quality dissertation. This sort of mentor should not only support your dissertation endeavors, he or she should encourage you to develop independence.

Gathering information to choose a mentor:

1. In choosing an **undergraduate mentor,** you should consider a variety of issues, including the compatibility of your research interests, the availability and approachability of the mentor, the success of that individual in the field, and the mentor's ability to help direct you into a educational/career path that will be both successful and fulfilling. In some cases, undergraduates have little choice of research mentors. My college only had one biochemist in the chemistry department at a time, so since I was interested in biochemistry, that person became my research mentor, by default. Had I thought more broadly, I might have found a research mentor in the biology department who was doing work that was close to my interests.

2. In choosing a **professional advisor,** which may or may not become a mentor,inquire about successful professionals in the field that you admire. Consider individuals like your dissertation advisor, dissertation committee members, department chairs, other scientists or engineers, as well as get recommendations of other individuals in the field.

Mentor versus Role Models

Some people provide valuable encouragement, guidance or inspiration, but do not fit the role of professional advisor because they have little knowledge about professional skills. My 8th and 9th grade science teacher was a true mentor. Genevive Cousins not only "adopted me" and treated me like her daughter, she taught me important principles of scientific writing. Every week I turned in a progress report on my science fair projects, that she returned covered in red ink. I won the Southeastern Division of the Ford Foundation Future Scientists of America Science Paper Writing Competitions in the 9th and 10th grades. As I matured, I found that the principles Mrs. Cousins taught me provided an excellent foundation for writing an NIH NRSA post-doctoral fellowship and numerous grants and scientific papers.

Gladys Mallory was a powerful influence and role model, but not a mentor. My mother was sick a lot with unexplained illnesses. I always hoped that Gladys would be working at the hospital as we raced my mother to medical care. I was 15 or 16 years old the night that Gladys leaned across the bed while she was checking my mother's vital signs and said, "There's something I always wanted to do." I yawned, "What's that Gladys?" "I want to be a real nurse." That caught my attention. She was so competent that it hadn't occurred to me she wasn't a "real" nurse. Gladys was the first African American nurses' aid at our parish hospital, in an era when some white patients would not let her touch them. I naively asked, "Why don't you go to college." "I can't pass chemistry," she responded. "Oh, don't worry. If I'm in town I'll be glad to help you." Several years later I had become a chemistry major at our local college and Gladys contacted me. She had started a two year associate degree in nursing and was failing chemistry. We started working together after the second test. She stayed in the class until the last day to drop - there was no way to pass that semester. But, she passed the chemistry course the next semester and the semester after that and she finished the associate degree. Then she finished a R.N. degree, then a Master's Degree in Nursing while she continued to work full time and be the mother to three children. At times she got up at 4 am to wash and iron her children's clothes, drove 70 miles each way for clinical studies in a larger town, worked a shift at the hospital and then got up and did it all over again. Gladys
became the supervisor of the intensive care unit at our hospital and according to one physician, "...was the best nurse in a 60 mile radius." My mantra in grad
school was, "If Gladys can do it, so can I." Gladys Mallory didn't have to know more chemistry than I did to teach me valuable lessons about persevering toward your goals.

3. In choosing a **dissertation advisor,** you should review the science literature and look for someone in your area of research interest that is producing quality research and publications and has a clear future in that area of science. Good graduate schools provide a period of time during which you "rotate" in a lab to get a sense of whether you'd like to join. You should consider how well you might interact with the advisor, the faculty, other students and post-docs in the lab as well as the overall atmosphere of the lab. Ask about the track history of the potential mentor in graduating Ph.D. level scientists/engineers. Some faculty are good scientists but terrible mentors. Also look into the careers of past students or post docs to see, in general, how well prepared they were to continue a career in the field. Finally, you should try to match your goals with the interests and demands of the advisor to ensure that the experience is most helpful in establishing your career.

Approaching Individuals about Mentorship:

1. When you, as an undergraduate, approach someone about being a general mentor, you will want to take a similar approach to someone seeking a dissertation advisor. Although a general mentorship generally requires a less significant commitment than a dissertation advisor, this relationship will likely span a considerable period of time and be important to your future in the field, so take this meeting seriously. Explain why you want the person to provide you with advice.

2. Approaching an individual about becoming a professional advisor is much less formal that approaching someone about being a research or dissertation advisor not only because you are asking them for a much less significant commitment, but because you will require much less time from them. Make an appointment with them, asking when they would have time to discuss a specific issue/question. Depending on how successful the first encounter was, you may want to follow up with more extensive questions.

3. In approaching an individual about becoming your research advisor you should make an appointment and outline the reasons you would like to join their lab, communicating your interest and experience in their

research. Don't panic if your first choice doesn't choose you. Consider approaching other mentors. And if you end up turning down faculty that offered you a position in their lab, try to let them know of your decision in person, and without burning bridges or destroying relationships. You may want to ask them to be on your dissertation committee, become a collaborator, or become an informal advisor.

General Pointers for Working with Mentors

1. You must accept responsibility for your own career. Others can help you, but don't count on somebody else to take care of you.

2. You will have different mentors at different points in your life. Different mentors will provide different types of help and support.

3. Don't look for mentors who just remind you of yourself. Most of my mentors have not been women. When we started an Initiative to Maximize Student Diversity in the Graduate School of Biomedical Sciences at BCM, we had few faculty who were from under-represented minority populations, but a number of people wanted to help Ph.D. students develop their careers. Some of them have been excellent mentors for students from different ethnic/racial backgrounds. Between 1998 and 2005 we increased the number of Ph.D. students from 20 to 100, with as many as 63 enrolled at the same time and 18 granted Ph.D.s.

Who do women undergraduates see as mentors?

A survey of mentor issues with 123 women alumni of the SMART Program revealed interesting information. Mentor relationships were considered as very important by 62% of the respondents and as unimportant by only 6% of the students. The undergraduates listed a variety of people who had been mentors, but there was a correlation between the education level of people and the frequency with which they were identified as mentors. Faculty were the most frequent mentors and cited by 77% of the respondents. The most valuable characteristics of mentors were being approachable, knowledgeable and that they challenged the mentee. The characteristic that ranked the lowest (8th) was kindness. Students didn't appreciate those who were too afraid of hurting their feelings to be honest. The most valuable aspects of mentor relationships involved practical issues with

writing letters of recommendation as the most important function. Discussing career opportunities and discussing science were the other functions ranked as important. Many women felt the gender of the mentor wasn't relevant. Only 12% of those who listed males as mentors thought gender was relevant, while 68% of those who had female mentors thought the gender of their mentor was relevant. (The survey was funded as a part of the NSF Model Project for Women and Girls (HRD-9631519) through which the first SMART GRE prep workshops were developed.)

4. A mentor can help you understand the system, provide encouragement and relate personal experiences.
5. You must help your mentor understand your background, strengths and weaknesses. A mentor can't help you with a problem you won't discuss.
6. Criticism is often a necessary part of growth. Don't discount a mentor because of a lack of tact. Even people with your best interest at heart may "stick their feet in their mouths" or find it difficult to discuss some situations.
7. Mentors are usually busy people; don't give-up on scheduling discussion time.
8. Mentoring can occur in short spans of time.
9. Learn to recognize when the mentor relationship is beneficial and when it is not.

Working Effectively with Your Research Mentor

1. Understand the demands of working with each mentor. How many hours per week are you expected to work? Will you need to do some work at night or on the weekends? Be sure the hours and safety conditions are reasonable relative to your other responsibilities. Failing classes because you spend too many hours in the research lab will not be viewed as a wise choice.
2. Read information on the project and ask for help in understanding it.
3. Take notes and pay attention when people take time to teach you things. Don't pretend you understand or know something when you don't. This can lead to major mistakes.
4. Be sure you keep good records in the form that is used by the lab (see section on Data Management). Keep your reagents, equipment, materials organized and labeled.
5. Admit mistakes when you make them, but don't keep reminding people of them.
6. Communicate with your mentor, whether in person, by note or by email.
7. Keep appointments with your mentor. If it is impossible to get to a meeting, let your mentor know why you missed the meeting as quickly as possible.
8. Maximize the impact of time with your mentor by:
    - reading or reviewing relevant information
    - organizing your information
    - preparing what you want to say
    - bringing clearly labeled data and information to the meeting
    - presenting a plan, even if it isn't perfect
    - taking some notes so you are sure you know what was decided
    - following up with a written note, maybe only a short note, reiterating what was discussed and decided (Your mentor will let you know if this is not needed.)
9. Work hard, but work smart. There may be a faster, easier way to get to the goal.
10. Express an interest in the work.
11. Treat your co-workers with respect and be a good lab citizen in terms of keeping things tidy.
12. Allow enough time for your mentor to critique abstracts you write or posters you prepare.

13. Pay attention to advice. If you don't agree, express your opinion in a professional way.
14. Let your mentor know you appreciate the time she/he/co-workers spend to train you.

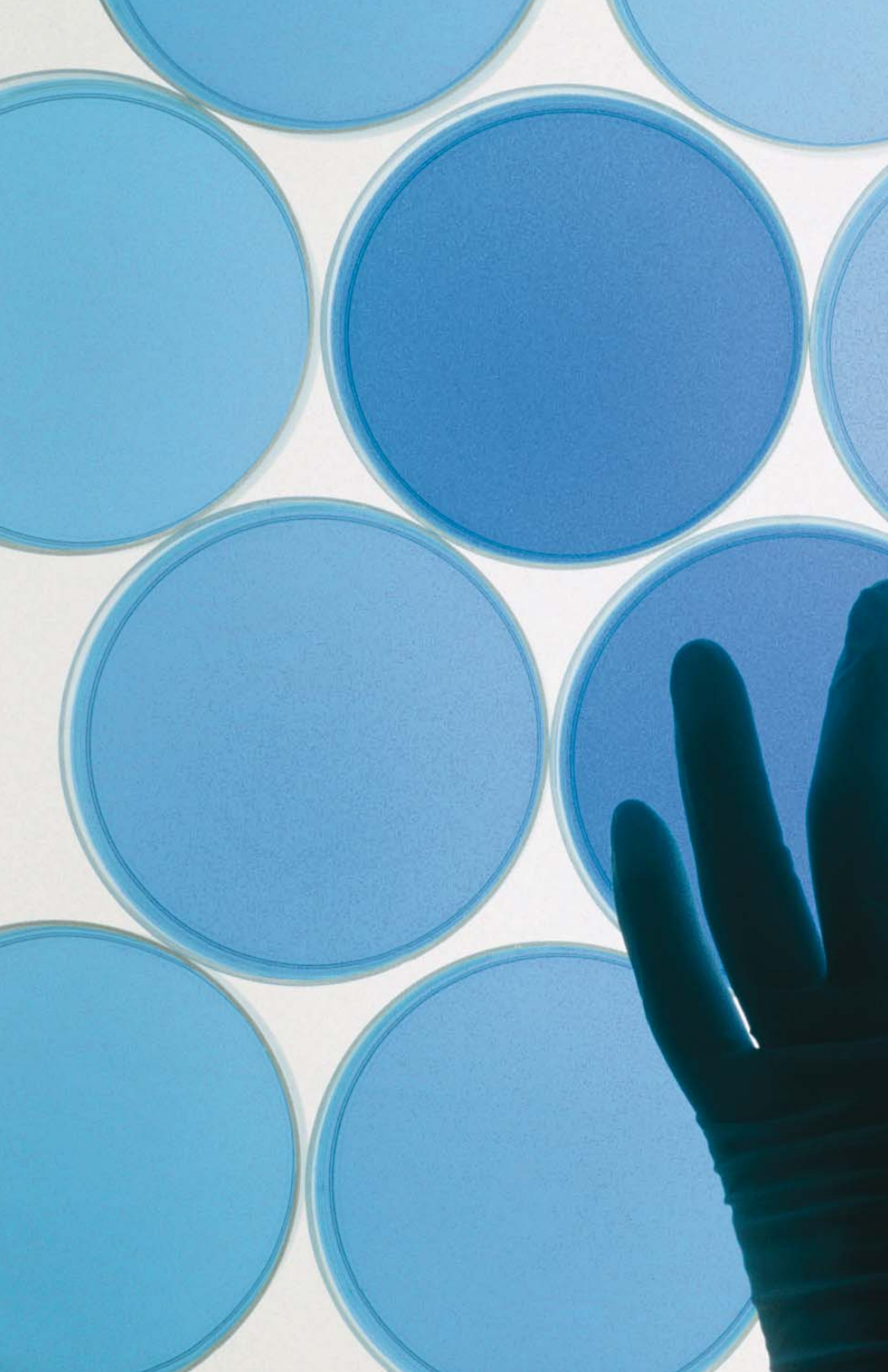
Making Your Way Out of Mentoring that Becomes Messy:

1. Look for signs that the relationship isn't working. This can be anything from lack of communication or derogatory language to inappropriate criticism or behavior that approaches harassment. Not every student will, or should, be treated the same. Because of differing personalities, some students require more encouragement to reach their potential, while others need blunt criticism. Recognize the difference between individualized treatment and unfair or abusive treatment.

2. Seek advice and try to reconcile the differences. Talk with other trusted faculty, in a professional manner, about the situation. Generally, you should avoid discussing the situation with other students because they may not have the experience or knowledge to objectively assess the situation. Depending on the severity and time-frame of your problem, you will either want to continue the relationship, despite the differences, or you will want to make a change. If you are in your last year of graduate school or have limited opportunities as an undergraduate to change mentors, you will probably want to make it work. Often many problems can be solved simply by having more frequent and organized communication with your mentor. However, in more serious situations, you may need to involve your program director or meet with an external mediator to resolve the problem.

3. Finally, if it still isn't working after you've made an effort to resolve the differences, know that it is okay to change mentors. Finding a different mentor may be worthwhile for your career and your psychological health. Sometimes, no one is really at fault, it's just that two good people don't fit each other's styles, habits or philosophies. Good graduate schools will help students make transitions between dissertation mentors.

4. Depression in either the student or mentor can torpedo a relationship. A high percentage of people will experience depression at some time in their life. Luckily, today there is help for coping with the lack of energy, interest in life and work and hopeless feeling that accompany depression. If you think you are depressed, please talk with someone who can help or find help for you. Many very successful scientists have coped with this medical problem. An engineer , who charted his moods very carefully, played an important role in identifying one of the most manageable manic/depressive diseases. Seasonal affective disorder or SAD, is linked to extreme responses to low levels of sunlight in winter. Millions of people have found their brain function stabilized through understanding the cause of their symptoms and using light therapy to regulate sensory input, thanks to an engineer who keep meticulous records, even when he felt terrible.



Chapter Five: Data Management

Why are scientific records important?

1. Documents the procedures, samples and reagents used for experiments.
2. Provides a record of progress for granting agencies.
3. Provides a record of results and achievement for publications and/or patents.

Ownership of scientific data:

1. The institution to which any specific grant is awarded owns all the data.
2. The principle investigator of the grant has ultimate responsibility for the records.
3. All records should be maintained for at least 5 years after the grant has expired. Some people have every lab notebook they or their labs have generated.

Responsibility of data acquisition:

1. The person doing the experiment is responsible for collecting and recording all data.
2. The supervisor should oversee data collection and recording, provide advice as to the system to be used, allow time for keeping and reviewing records, and critique record keeping.
3. Follow the rules of the workplace regarding types of records, access to records, duplication of records, etc.

Systems of data acquisition:

1. Daily notebooks: bound journals or loose-leaf notebooks containing experiment description, data, interpretation and conclusions
2. Procedure or reagent notebook
3. Computerized records and logs
4. Primary data, if it can't all fit into notebooks
5. Summaries of findings

Sample Format for Experiment Description:

- Title of experiment
- Objective, purpose of experiment
- Rationale for doing experiment
- Procedures and reagents
- Experimental design: details of samples, set-up, procedure
- Results: primary data, calculations, graphs
- Conclusions: interpretations of results, future experiments

Organizing Your Lab Notebook: (adapted from a presentation by Susan Hamilton, PhD, Chair of Molecular Physiology and Biophysics, BCM)

1. When possible, use hardbound notebooks. Some data, however, may be too large for a hardbound notebook and a binder will be necessary. Be sure to date and initial all entries.

Notes on scraps of paper or unorganized loose papers are unacceptable forms of lab notes! I've actually known students who thought they could keep up with information written on paper towels. Their work was as unorganized and inefficient as their notes.

2. Table of Contents-You should leave a few pages at the front of your notebook blank for the table of contents. Usually the contents are organized by date. You should include page numbers and categorize by techniques and protocols, type of experiment, or title of experiment. Denote experiments that yielded publishable data with a * by the entry. You may want to place another copy of this data in a separate notebook. Remember to update the table of contents at least weekly, daily is even better.
3. Experimental Section
    a. Date and a Title: Title should be informative, allowing you to discriminate this experiment from similar ones.
    b. Purpose of the Experiment: State the hypothesis to be tested, observation to be confirmed, etc. The section should make it very clear why you are doing this experiment. You may want to add a "Rational for the Experiment" section.
    c. Equipment and Material: This section helps greatly in planning the experiment and anticipating needs to carry it out. You should also describe the preparation of any solutions to be used. If the experiment does not work the way you expected, the details recorded in this section will help you with troubleshooting.
    d. Protocol: Written before starting the experiment, this section should contain a step-by-step description of the experiment. Any changes made during the course of the experiment should be noted in the margins. It is better to have a slightly messy lab book than an inaccurate one. You don't have to re-write every protocol every time you use it, but you could paste in a copy of the protocol or refer to the first time you described it in detail with a specific note about the experiment in which the details are described. Be sure to note any changes to protocol. It may help to designate a

number for each experiment. Yes, that can be depressing – I clearly remember how I felt when I wrote the number 110 on a Western blot designed to find an elusive protein.

e. Observations: It is important to note any unusual occurrences observed during the course of the experiments (for example, a solution appeared cloudy or the amount was not what you had anticipated). Any mistakes should also be noted. This information will also be useful for troubleshooting.

f. Data: Data (such as the printouts from equipment such as Liquid Scintillation Counters) should be placed directly into the notebook (usually taped or stapled). This section should also include flow charts (which are highly recommended for complex, multi-step experiments), graphs of data, pictures of gels, tables, etc. Obviously some data cannot be placed in a notebook. This data should be described and the actual location of these items should be noted. Data collected on a computer should be stored on a diskette or CD, labeled with the date and title or number of the experiment. The contents, file names, and location of the diskettes should be described in your notebook. Hard copies should be initialed and dated.

g. Data Analysis: Include the tables or graphs that summarize your data. Record the results of curve fitting or transformation or analysis of data. Any equations used to fit or analyze the data should be recorded in this section. This section should also include a description of any samples which were saved and where these have been stored (room number, freezer, bin number, etc.).

h. Conclusions: Are the results conclusive? What information have you obtained from this experiment? Does this experiment satisfy the original purpose of the experiment? What modifications should be made in the original hypothesis? Based on your findings, what new experiments need to be done?

i. Summary of Discussion with Mentor: Put this in your own words and ask mentor to initial your summary to insure accuracy in interpretation. This section may not be needed after every experiment, but rather after a series of experiments. It is also useful to write down suggestions given to you by others in the laboratory and note who made these suggestions.

j. Your Signature and Date of Analysis Completion: Only do this if it

is different than the date of the experiment. A number of experiments take days or even weeks to conduct from the beginning to end. This is why some labs use loose-leaf notebooks or have different notes books for different projects that may overlap in time. It is not unusual for Ph.D. students to work on several projects simultaneously to make good use of "wait times".

If you are working for a company or on a project that is anticipated to yield patentable results, the system of record keeping may be very structured to comply with legal requirements regarding keeping records. You might work on a proprietary or government project that is even "classified" due to national security. There are a number of physics, computational or infectious disease projects that might fall into a "classified" category. Be sure you know the conditions of reporting what you have done before you agree to spend time on a project. Some work done at companies can be discussed in general terms that will allow members of admissions committees to evaluate how a work experience has helped prepare you for graduate study. Be sure you understand the limits of what you can tell those from outside the setting where you worked. Working on "proprietary" projects will not interfere with your acceptance at school if you clarify how you can relate the experience you gained without revealing confidential information.

Making Corrections to Lab Notes:

1. Find mistakes. Look for errors or omissions in calculating or recording data.
2. Do not erase or use white-out. Instead, draw a line through what is being changed and write above or in the margin the change. Date and initial the change in a different colored ink. If you are changing a computer record, strike through the mistake, add a blank line and put in the correction with a date beside it.
3. Include new information that changes the interpretation. This is more of an addition than a change. Include an explanation of why you made the change. Date and initial the change.

Guidelines for Computer Records:

1. Back up everything.
2. Number and date every page.
3. Be honest and complete about the information.
4. Include a sufficient amount of information to understand and potentially repeat the experiment.

5. Keep data up-to-date, keep all primary data in a specified, easy to find place.
6. Keep a record of un-manipulated data.
7. Maintain data for at least three years after the completion of the project.

Concerns about Computer Records:

1. Difficulty inputting some primary data
2. Ease of manipulation, there is a temptation to alter data
3. Easy loss of data that has not been backed-up
4. Constantly changing computer systems
5. Hacking or duplication (for sensitive information)

Results of Bad Record Keeping:

1. Difficulty understanding research
2. Difficulty reproducing results
3. Inability to document process and progress
4. Difficulty in responding to questions about results
5. Inability to defend challenges that arise
6. Lost of public trust. High visibility fraud, or even suspected fraud, cases harm science tremendously. Research is funded by tax dollars, personal contributions and business that relies on shareholder confidence. When people question the honesty of scientists, it affects the resources to make discoveries and translate knowledge into practical applications.

Keys to Reliable Record Keeping:

1. Provide a table of contents in each book
2. Keep all records up to date
3. Number experiments in a series in order
4. Put all primary data in the lab notebook if possible. If not, then put it in an easy to find place, and note the location in your lab notebook.
5. Make corrections in a different color and date/initial them
6. Ask yourself these questions:
   → Could you understand the lab notebook ten years from now?
   → Can anyone who didn't do the experiments repeat them?
   → Can you find the primary data and materials used to do the experiments?

Chapter Six: Reading the Scientific Literature

A huge part of your success as a researcher depends upon your ability to read, understand, and use the literature in your field. However, scientific articles can often seem too dense, esoteric and technical to really comprehend, especially early in your career. Therefore, it can be very beneficial for you to know what to look for and where to look for it. It is important that you set aside time each week to read the scientific literature. If you miss your usual time, try to make it up the same week. Consistent exposure to the ideas and concepts in the literature is the key to gaining understanding. Keep a record of the time you spend reading scientific papers to help you realize when or why you are not spending sufficient time reading. It will also provide a document for your mentor as to how you spend your time.

General Pointers

1. Reading must be active, not passive. It doesn't help to run your eyes over the words if you are not processing the information. Mark up the paper.
2. Use different colored highlighters to emphasize different points. For example: yellow for strategy, green for techniques, red - actually pink - for results, blue for conclusions/implications. Maybe you want a system that color-codes things based on your evaluation. When I review grants I use yellow for facts, green for what I view as positive or "good", pink for what I have concerns about or think is "poor". People ask me how I can comment on grants I wasn't even assigned to review. I can easily flip through the pages and find the highlighted comments.
3. Use a standard set of abbreviations to draw your eye to points, for instance: VIP (very important point), ?? (question), BG (background), C for conclusion.
4. Read the paper through once for the big picture, then return to the details if appropriate. You may decide the paper doesn't have what you need after the first read.
5. Make a summary of the paper. Include things like the big question being answered, the specific focus of the paper, and the conclusions and implications of the research. Often you can organize this information into a flow-chart of the experiments conducted and the results or a one page summary. Be sure to include your own critical analysis of the paper.

Assess its methods and conclusions. Science is a field where healthy skepticism is essential. Scientists should make their case as clearly as possible and qualify their conclusions. You will become more comfortable analyzing papers with practice. Make whatever comments you can for your stage of development. You may return to a paper at a later data with a completely different perspective.

6. Organize and file the papers you've read. These can be useful for later research, journal clubs or abstracts you write. Numbering articles is a useful way to limit the amount of writing you do when referencing articles for your own informal use. Remember to use proper citation methods when it comes time for formal paper writing, though.
7. Discuss what you read with others. Study groups, journal clubs and lab groups are all valuable ways to better understand the literature you are reading. How much more will your career benefit form discussing a scientific paper with a friend than obsessing over football scores or the latest dating scandal of a rap or rock star.

Locating Papers

Consider the following sources for locating papers that are both worth your time and important for your success.

1. Papers assigned in class.
2. Papers recommended by your mentor, colleagues or for journal clubs.
3. Papers located by searching journals, like Science and Nature or Engineering News
4. Use a database to perform a targeted search. The free PubMed service (over 12 million references included) allows you to search by subject, author, journal, publication date and more. Often you are given the abstracts of the papers, and sometimes you are even given the full text of the article. Look at links like: *http://www.ncbi.nlm.nih.gov/ or http://www.nih.gov* and follow the links to library resources.

Publication Myths:

Readers start with myths they must unlearn to effectively read the literature.

1. **If it's published, it must be true.** Both authors and reviewers can make mistakes in all steps of the research process. Maintain a critical perspective while you read.

2. **If it's published, it must be important.** There are journals that publish repetitive or trivial work hoping that what looks trivial today is recognized as significant tomorrow. There are hundreds of journals that very few people read. Some times people start a journal because they can't get their work accepted in established journals. Some very prominent, high quality journals began this way.
3. **No one would publish a figure where you can't see results.** Some scientists will publish anything they can get by their reviewers. Often a researcher's wishful thinking gets in the way of their ability to objectively analyze their results.
4. **If you can't see results, it's the author's fault.** Information and resolution is often lost in reproduction, especially if poor quality paper is used to produce or print the article. Some results can only be seen if printed in color.

Reading Objectives:

Use the right approach depending on your purpose in reading a paper. Consider the following objectives:

- Looking for hot discoveries
- Searching for applicability
- Researching a technique
- Reading for background information
- Analyzing a paper (focus on the soundness of science)

1. Looking for Hot Discoveries:

Reason-You might want to look for hot discoveries in order to keep up with the advances being made in science and find areas for further development. Often doing this can be the difference between a modest and a sky-rocketing career.

Focus-Look primarily at key words and statements about uniqueness found in the title and abstract. Also look at the data and discussion, searching for ways it connects to your own work.

Hint-Keep a file on interesting ideas that might connect to your work or problems you would love to solve. These papers might become the basis of a NSF fellowship proposal.

2. Searching for Applicability:

Goal-Is this paper worth more time? Do I move onto a paper referenced here?

Reason-You might consider this objective if you are trying to accumulate papers for a project, are trying to find more details on an interesting topic, or want to know how to approach a problem and what techniques to use.

Hints-Limit the time you spend identifying if a paper is worth copying or downloading from the internet. Use key words in the title, abstract, headings, discussion and first sentences of introduction and discussion to effectively identify important information.

3. Researching a Technique or Procedure:

Reason-What techniques/procedures have been used to approach this problem? What is the power and what are the limitations of this technique? How was a procedure implemented?

Hints-Focus on the methods and results sections. Sometimes figure legends are helpful. In the methods section look for a description of the procedure itself, the limitations of the procedure, and the suppliers of reagents, materials, equipment. Too often you will be referred to a previous paper. Just be patient and follow the lead from one paper to the next, and sometimes the next and next. You can find supplementary information at: *http://www.biovisa.net*

Warnings-Be careful when a lot of data is not shown or discussed. A copy or downloaded document may not allow you to accurately evaluate results; many figures are in color. Some techniques won't perform as described because of inadequate information. You may want to contact the author directly to ask detailed questions. Some authors cite irrelevant papers, usually their own. I hate that!

4.Reading for Background Information:

Reason- Often this technique is useful if you are starting research in an unfamiliar area and want to know what has already been accomplished. It is also beneficial for someone exploring a project or area for further study.

Hints-

a. **Abstracts:** Read carefully to get the feel of the paper. Note key words and highlight important points. Notice what the authors considered to be their contribution.

b. **Introduction:** Because it generally summarizes discoveries in a field, this is often a helpful resource for background references and review articles that summarize a lot of work in the field.

c. **Methods and Techniques:** You should read this early on if you are unfamiliar with the area. If you are familiar with the techniques, save this part for later. Never focus on the details here!

d. **Results:** Start with the data itself, like graphs, tables, photographs and figures. Search the text for qualifiers and details that change the interpretation of the data.

e. **Discussion:** This section is very important as you are learning a specific area of study. Look for places that you find correlation with other studies or creative/speculative ideas.

5.Analyzing a Scientific Paper

Reason-You might want to analyze a scientific paper while you are learning to read the literature or if you are participating in a reading rotation with faculty, if you are learning to improve your own writing skills, if you are looking for support for your ideas or results, or if you disagree with the authors' conclusion and are looking for flaws or differences between your work and theirs.

Focus-Prove it to me!

Hints-This is a time-consuming, detail-oriented analysis so find a comfortable, quiet location to read. You don't have to be indoors, if you can concentrate. This may be the best justification you can come up with for buying that iPod with your favorite "focus music". Pay most attention to the abstract (to orient you), the appropriateness of the techniques, the information being presented, the validity of the information and the appropriateness of the conclusions. Additionally, look at the organization and clarity of the paper and the authors' ability to communicate his/her/their points clearly and efficiently.

Secondary concerns:

- organization of the paper
- clarity of the paper
- efficiency of communication: **Be concise, be precise**

Analyzing Components of A Scientific Paper

You'll develop your own system of analysis as you gain an understanding and confidence in evaluating the literature. These pointers may help you get started as a critical analyzer.

Title:	Does it overstate the case or imply progress not made?
Abstract:	What is the significance of the work? Is it clear? Does it get to the point? Are appropriate results (data) included? What are the conclusions? Are the conclusions overstated?
Introduction:	Does it clearly state the purpose and significance of the work? Does it provide enough background for the reading audience? Are helpful references provided?
Methods:	Is there sufficient detail to understand what and how the work has been done? Is there sufficient detail given or referenced to use the techniques? Would other techniques be more useful?

Warning: Do authors inappropriately reference own work? This means do you end up following four papers to get back to the "real" reference that tells you how the work was done? Always reference the paper where procedures are described.

Data:
Has the necessary data been included?
Is the paper padded with unnecessary figures?
Is the data well organized and clearly presented?
Were appropriate controls used and shown?
Were correct techniques used to answer the questions?
Are graphs and tables used appropriately?
Is data correctly and clearly labeled?
Were correct statistical methods employed?
Are the figures effectively described in the text?

Results:
What are the significant findings? Do you agree or disagree?
Do the results in the text agree with the figures?
Can the statement in the text be verified by the data shown?
Are appropriate details and qualifiers included in the text?

Discussion:
Are the conclusions sound? Do you agree or disagree?
Is it just a recapitulation of the results? BAD!
Is the work presented compared to previous studies?
Are controversies in interpretation discussed?
Does it include new data, raise new issues and ideas?
Does it contain irrelevant information?

Chapter Seven: Plagiarism and Copyright Infringement

Plagiarism is a short cut... to failure.

Good scientists know the literature and don't appreciate people who abuse others' work.

What is Plagiarism?

- Passing off the words of others as your own
- Presenting the intellectual work of others as if it were your own. This includes ideas, not just words.
- Plagiarism is a form of both intellectual theft and intellectual fraud.

Avoiding Plagiarism:

- Give credit where credit is due.
- You are not expected to include only new ideas in your writing or talks.
- You are expected to know and reference the literature.
- Failure to cite skillfully may constitute plagiarism.

Mechanics of Citation:

- Citation means referring to previously published work.
- Keep a record of where your information comes from, the actual papers, abstract page, or notation about the article so that you can find it to be sure you are using information correctly.
- Use computer bibliography managers to help with your references.
- Be careful to use a proper style of citation: avoid quotations and always follow information with a reference number or name. Look at published work to see the styles of citation. Unfortunately there is no completely uniform style of reference format for all journals. Bibliography managers will format references for you from a database of info about the article.

Examples of Citations:

- According to Smith and Jones (12)…
- My work is in agreement with that published by Smith and Jones (12) in which they found…
- There is a 14 fold increase in RNA (12)…

Common Questions about Citation:

1. **When do I quote?** Quote strings of words containing three words or more from the source. Although, sometimes single words, when used in a similar enough context, should be cited as well. Straight quotes are rarely used in scientific writing, unlike some liberal arts literature.
2. **How do I paraphrase?** Rewrite the idea in your own words, but be sure to cite it. It is better to synthesize ideas than to paraphrase. Instead of summarizing a work, try analyzing or critiquing the work.
3. **Which ideas should I cite?** Any ideas that are not your own, or among the intellectual commons of your field.
4. **How do I know which ideas are the intellectual commons of my field?** Note which facts are rarely referenced, like "complementary base pairing allows hybridization of nucleic acids". Pay attention in class. Read contemporary articles, textbooks, and reviews. Attend meetings and ask questions. Know that the "commons" changes as members join or leave a field, as ideas come and go, and as scientific fads emerge and disappear.

Summery of Pointers:

1. Cite important findings.
2. Don't cite everything ever written on the topic.
3. Read all of the references you cite.
4. Get permission from the journal, book and authors to use any copyrighted work, especially figures. If you are using direct copies of figures from even your own paper for another publication you must have permission from the organization that published the work. America has laws that protect use of published material.

**Material in this section was adapted from presentations by Gayle Slaughter, Ph.D. and John Rodgers, Ph.D., Assistant Professor of Immunology at BCM.*


NAME
NOM
Expense Report

Chapter Eight: Research Proposals/Fellowships

When would you write a research proposal?

Even undergraduates may write research proposals for a project, a senior thesis, a fellowship application. NSF and a few scientific societies accept fellowship proposals from seniors who can them use them at any graduate school to which they are admitted (http://www.nsf.gov). Most Ph.D candidates will write research proposals for their qualifying exams and possibly for pre-doctoral fellowships.

General Pointers:

1. Realize that while writing a research proposal might seem overwhelming, with organization and preparation, it doesn't have to be a daunting task.
2. Expect writing a proposal to take work and planning and make sure you allow an adequate amount of time for each step. The level of detail required will depend on the page length and your stage of career development. No one expects a college senior to write the same type of proposal as a Ph.D. candidate writing a qualifying exam proposal.
3. When brainstorming to find a topic, consider looking into ideas from classes, seminars, or something you read that caught your attention.
4. Realize that while it is important that your topic be interesting, your goals should be achievable. This means you must have a sufficient amount of background information on which to base the study and a realistic plan to accomplish the goals. You're not proposing a plan that would take 10 people 10 years to do the project.

Common Components of a Research Proposal:

1. Typical proposal format
   (extent of details included will vary with the page limit)
   - **Aim:** to ask a question or put forward a specific goal, not to suggest a specific experiment. Clearly define your purpose with precise questions you wish to investigate and the techniques that you will utilize. Often having 3-4 aims is an appropriate amount. Be sure that doing the project does not depend on a specific outcome from the first aim.

- **Background:** What is known and unknown about the problem you propose to study? Why is the question(s) you are asking important? What will be gained by answering it? What are the controversies related to the topic?
- **Experimental design:** What experiments will you do to complete the aims, test the hypothesis and answer the questions? For each experiment include a purpose, the techniques you will use and how you will interpret the data.
- **Methods (sometimes combined with experimental design):** What are the specific techniques and procedures you will use in your experiments? Describe the techniques in the amount of detail that is appropriate for the length and sophistication of the proposal. A two page proposal leave limited space for discussing the details of technical issues. For longer proposals you can point out the advantages and disadvantages and the limits of the technique. You should consider limitations like: sensitivity, expense, number of animals, precision of data, amount of computer time required, etc.
- **Conclusions:** What do you expect to learn? What problems could arise? What other approaches might you consider? While the depth to which you can address other approaches varies with the length of the proposal, it's good if you can include at least a statement about alternative ideas.

Common Barricades to Writing:

1. **Don't know enough. Solution:** Read the literature, talk to experts.
2. **Can't get organized. Solution:** Get all your information together and organize it by type of information or the point it supports. Start brainstorming your thoughts in any order, and go back later to organize them in a logical sequence.
3. **Too overwhelmed. Solution:** Break down the project into smaller units, 1/2 hour or 1 hour increments, start typing without being critical about your words so you can get started.
4. **Language barrier. Solution:** If your barrier has to do with the technical language, keep reading the literature and talk to experts for explanations and clarification. If your barrier is that English is your second language, then have a dictionary in hand while you write. Also, be sure to discuss

your project with others, and have them read through it to critique your wording. You might have to write the proposal in your native language, then translate it into English. You may even want to find an organization that helps people improve English skills.

5. **Not in the mood. Solution:** Get over it and just do it! A lot of good writing happens when people aren't in the mood. Often what happens is you'll keep procrastinating until you have so little time to write that you get stressed out and even more overwhelmed. Just start writing. Create an atmosphere conducive to productive writing by eliminating distractions, having the "write" resources (laptop, papers, a quiet place, the right music to help you concentrate. If you get the fellowship maybe you can buy the iPod (not on the grant,) with the money your Dean should give you for being industrious and getting your own money.)
6. **Waiting for adrenalin to flow. Solution:** Never wait too long, even if you "work better under pressure". Pressure can cause you to judge your work inaccurately.
7. **Really blocked. Solution:** Pretend you're giving a talk and start taking notes. Discuss the topic with a friend and have paper or a laptop ready.
8. **Scared of writing. Solution:** The fear is usually much worse than the act. What's the worst that can happen? Someone who sees it will think you are not a good writer. So, learning to write well is part of your education. Not writing will really inhibit your career progress. It's not as hard as you think.

How hard can it be to write a fellowship proposal?

I left graduate school terrified of writing grant proposals. I'd seen faculty hide from everyone for months while they wrote proposals. It seemed like a daunting task. My post-doc mentor, Anthony Means, Ph.D., tricked me into writing a NIH NSRA post-doctoral fellowship by telling me it wasn't a real grant and that I probably wouldn't get it because it was so competitive, but he thought it would be a good experience for me and after all he was funding me. Well, he lied, at least about it not being a real grant. It was a small grant for one person to do in three years. But an amazing thing happened. As I started thinking about how to study protein phosphorylation in a totally new system to me, I started having fun writing the proposal. By the time I had completed the proposal, I had finished something that I didn't do earning my Ph.D. I had developed a logical plan beginning to end to answer a relevant biological question. My Ph.D. dissertation project had evolved so gradually and with so many dead-ends that proposing a new project was a joy. What was even more amazing was that the proposal was funded and my plans worked. The same skills that I used writing the fellowship, I later adapted to writing educational grants. Leaving graduate school I would never have imagined that some day I would write and supervise projects that garner a million dollars a year to train the next generation of scientists. Grant writing phobia – be gone!

Practical Considerations:

1. Inform others that you are preparing a proposal and let them know how much time it will take you to complete it.
2. Grocery shop, pay bills and wash clothes ahead of the deadline so you can focus on your proposal.
3. Don't worry about the small things that don't get done while you are working. You will have to sacrifice some things in order to devote extra time to you proposal.
4. Let people be supportive and recognize the value of constructive criticism.
5. Be cautious about discouragement regarding writing the application. If someone who reviews the applications, tells you that you won't meet the requirements for funding because you have a 2.7 GPA that is different from someone saying you shouldn't bother to write the proposal because no one from your school has ever received one. And if you had that 2.7 GPA, do better in grad school and then apply. Once people get turned on to science and start to meet their full potential, they may receive fellowships based on outstanding proposals.

Fellowship Applications

Purpose and applicant pool

Fellowships provide sources of funding to facilitate scientific training. Organizations seek to sponsor talented, motivated scientists with promise to develop independent careers. Fellowship awards are used for FOREVER in assessing your competitiveness for other funding. There are a few fellowships for which undergraduates can apply before they start Ph.D. programs, including those from NSF, which you then take with you to the graduate school you decide to enter. Realize that the earlier in your training you write the proposal, the less likely you are to do the actual project you describe. Review committees use the proposal to get a sense of what you know and how you think about science or engineering. You are not committed to doing the project you describe in a fellowship proposal.

Most fellowships are targeted toward developing scientists; pre-docs or post-docs or recent M.D.s seeking research training.

Many fellowships are targeted toward specific areas of research, mostly to provide young scientists with an introduction to a field of research, not necessarily a specific project. Others, for example NSF or HHMI, are designed to support phases

of education and training in science in general within broader disciplines. NIH fellowships are a hybrid designed to support training but are administered by agencies with specific scientific goals.

Budget restrictions

Most fellowships provide salary support. Many provide only partial salary, which may be supplemented by the lab or graduate school to bring the recipient to a standard compensation.

Some include funds for travel to conferences, supply money (computers, etc., but not iPods), or pay your health insurance.

Some provide tuition to the institution for pre-doctoral recipients.

Length of award

Varies with organization and purpose of award. Often a 2-3 year duration.

There are special awards for those writing dissertations.

Finding fellowship information

1. Use the web! Find links for NSF for fellowships that you can apply for in your senior year.
   Check websites for NIH and NSF for fellowships once you are in graduate school, the GREAT Group website (http://www. aamc.org/members/great), or those of professional societies that fit your interests.
2. Talk to others in your program and department, discuss opportunities with your advisor.
3. Your undergraduate research program office or career center may have a list of fellowships.

Preparing application materials

1. Get specific information from the granting agency. Follow all directions.
2. Be sure you are eligible for the award; pay attention to types of training covered, times during training allowed, degree plans allowed, area of focus, residency or citizenship requirements, special population requirements.
3. Match the time you can commit to the application requirements. Can you finish by the deadline? Does the application require a 2 page proposal or a 15 page detailed grant?
4. Make a check list of what you need to provide, which will vary between applications.
   Typical information includes some or all of the following: personal

data, GRE scores, transcripts, form pages (with signatures by institution officials), letters of recommendation, list of honors, abstract, proposal, explanation of how the fellowship will enhance your training or other essays, lists of presentations or publications.

5. Letters of recommendation are an important part of the application. The shorter your career the more reviewers rely on letters from scientists who know you and can evaluate your potential.
   Request letters of recommendation at least one month in advance (if possible)
   Inform recommender of the nature of the fellowship in writing
   Diplomatically ask recommender if he/she can write a good recommendation letter
   Provide information on your accomplishments (copies of abstracts or publications)
   Follow-up to see that letter is received
6. Applications may need to be submitted through an Office of Research, with appropriate forms.

Writing a proposal

1. Develop a concept; then clarify ideas
2. Conduct a literature search to find what hasn't been done
3. Assess resources and time for which training will be supported
   What other financial resources will be available to support the project?
   Should you consider involving collaborators?
4. Define the specific aims (what you hope to accomplish)
5. Write an abstract (may be required; good way to organize thoughts even if not needed)
6. Describe the research approach, the problems/limitations anticipated and approaches to solve the problem, achieve the goals, answer the questions
7. Once you know what you will do, get forms and institutional clearance for experiments
8. Emphasize the significance of your work
9. Provide background information that lays a foundation for your proposal
10. Create figures for your preliminary data , if allowed and you have any preliminary data
11. Get others to read and critique your proposal
12. Revise your proposal

13. Proofread your proposal
14. Review your checklist; file application and relevant information
15. Follow-up to be sure the application was received

Inter-, multi-disciplinary research is being emphasized as the key to science of the future. Remember those weird courses you took that weren't really required for your major, you just thought it would be interesting to take them? They may be the launch-point for thinking more broadly about how to approach a problem. Every science and engineering major would benefit from taking biology, chemistry, computer, physics, engineering and statistics courses. Or even better, maybe your campus has developed interdisciplinary courses or seminar series or journal clubs to help students develop broader perspectives on thinking about science and engineering applications. The "Fundamentals and Frontiers of Biomedical Research" daily seminar series offered by the SMART Program presents an overview of biomedical research from a multi-disciplinary approach that features geneticists or cell biologists one day, biophysicists the next, a computational biologist, a physician/engineer working on a biological problem the next day or even scientists who are knowledgeable in so many areas they can't be classified. When I developed a Minority Scientist Seminar Series at BCM, I was thinking about the students' need to connect with scientists from their own backgrounds. What I didn't think about until later was that when minority students came to seminars outside their field to hear inspiring speakers, they would gain broader perspectives on doing research. I'm trying to decide how to analyze whether that broader perspective contributes to the incredible success of minority students in BCM Ph.D. programs, particularly with respect to winning so many of our research awards and national fellowships *(http://www.bcm.edu/diversityprogams.)*

If fellowship is awarded:

- Review critique, if available, to improve outcome.
- Send a letter of acknowledgment.
- Review requirements for progress and final report.
- Outline timetable for work and relevant presentations or trips to conferences.
- Do the work! Or something related enough that it meets the requirements for support.
- Provide highest visibility for support; presentations, publications, letters to Congress.
- Always list the funding source on abstracts and publications
- Personally interact with representatives of the funding agency; email or at meetings.
- Send progress reports and updates.

If you don't get the fellowship:

- Realize that fellowship competitions are competitive. Many good proposals are not funded.
- Read the critique, if available, and learn how to improve the proposal.
- Make some notes on what you would do differently if you were starting over. Keep the notes in a file marked "the next success".
- Decide whether to resubmit the fellowship
    - Can you address the weaknesses?
    - Is there sufficient time to resubmit the fellowship before you graduate?
- If you decide to resubmit, be sure you address the reviewers, comments, update the proposal (check the literature for new papers), add preliminary data you've acquired

Chapter Nine: Writing Abstracts

Abstracts are important. People use them to decide which posters or talks to visit at meetings and which papers to read, to remind them of what they have learned or what you, as the researcher, have accomplished, and to communicate pertinent information to a wide variety of people. As short summaries of papers or projects, abstracts are effective not only because of their brevity, but because of their accessibility. PubMed, an international database for scientific literature, allows readers from all over the world to access the abstracts of thousands of scientific papers. Learning to write clear, concise and accurate abstracts for scientific purposes will be an important part of your career.

General Pointers:

1. Abstracts for meetings are often used to describe works in progress. Undergraduate projects may be presented at meetings or described to funding agencies with no real results, but with a clear understanding of what was done and learned.
2. Abstracts for papers are designed to entice the audience to read the paper.
3. Follow the given format and don't go beyond the length requested. Usually abstracts must be either camera ready or more likely, submitted electronically.
4. Be precise and concise with your words. Choose each word carefully to most accurately convey your project and its results.
5. Abstracts are usually written in the third person and with the passive voice. For example, "The p21 protein was localized in the hippocampus and cerebellum…"
6. Use abbreviations for terms used repeatedly, especially if they are long. Explain abbreviations that are not widely understood the first time they are used.
7. Avoid words and phrases that are indefensible, for instance: "always", "never", "proved".
8. Always have other authors, mentors review and approve your abstract

Organization and Content of Abstracts for Meetings

1. Titles should attract interest and be informative. They should not be cute or overstate findings nor should they be so long that they are cumbersome. For example: "A cure for prostate cancer?" versus "Characterization of ps20: a novel protein with growth inhibitory activity" versus "Characterization of ps20: a novel secreted protein from the smooth muscle cells of the prostate stroma that inhibits growth of the PC-3 carcinoma cell line".
2. Opening statements should state the reason(s) for the project and include long range goals and significance as well as the objectives, goals of the work to be presented.
3. The specificity and length of the introduction will vary with the knowledge of the audience; those less familiar with the research discussed need more extensive information. The introduction is usually a few sentences and should not exceed 1/2 the total length.
4. Methods and results should be combined to save space. Briefly cite the methods used, sometimes using familiar jargon.
5. Say something of value. Avoid statements that are empty. For instance, "There was a significant difference between the control and the patients' samples." versus "The antibody titer was 25 fold higher (p=0.05) in serum from infected patients than from control subjects."
6. Include significant numbers when available, but don't bog the abstract down in numbers. Use exact numbers only when necessary. Fold differences are often useful.
7. Avoid: "The results of these experiments will be presented." (Does this mean you haven't done the work, yet?)
8. You can include negative results. Experiments don't always give the expected or desired results. End on a positive note.
9. The conclusion or summary should effectively discuss what your results mean, suggest or contribute to the field. Using the phase "preliminary results" appropriately expresses reservations about work that has not been verified as sufficiently as needed for publication.
10. For more tips on how to overcome common barriers to writing, check out Chapter 7.

Common Mistakes in Writing Abstracts:

1. Assuming the reader knows why the research is important.
2. Using abbreviations without defining their meaning. While this may not be necessary for a specialized audience with a common frame of reference, many other audiences will require a definition.
3. Mentioning a gene, drug or protein without defining its action or function.
4. Failing to emphasize the uniqueness of a result.
5. Failing to explain the significance of a result.

Chapter Ten: Creating Effective Figures

General guidelines

- Focus on the message - the data, the meaning - we're scientists and engineers, not artists
- But visual impact is important and can get your work noticed or remembered
- Different types of presentations require different levels of preparation
- Invest an appropriate amount of time in preparing figures and slides
- Lab meetings are not Nobel Prize Award lectures, or even national conferences
- Posters for meetings and figures for publication are important; you are representing not just your own work but that of others, your program and your institution.
- Saving the reader time, by making it easy to follow your work, will gain you bonus points.
- People will respond differently to the same data presented in different formats
- You have different amounts of time to make a point in different formats
- Papers, posters, short talks, seminars may allow and require different formats or at least different levels of explanation of data
- Match complexity of figures to the time available to comprehend them
- Avoid including data you don't discuss because it distracts the audience from your points
- Borrow - don't steal; don't waste time creating everything yourself, but credit people
- Get an "in house" review; have others critique your work before you go public

Ways to present data

Word slide: background, hypotheses, strategies, summarize points/conclusions
Avoid too many words; if for a talk - use same words you will say
Letters need to be large enough to read comfortably

Flow diagram: pathway, developmental scheme, procedures

- Emphasizes concepts
- Eliminates a lot of unnecessary words
- Combine drawings with text to add interest; watch out for "time gobbler" in making beautiful slides

Tables: quantitative data or broad categories of response
Many variables (testing 12 detergents to solubilize receptor).
Responses to a series of variables
Summary of data (kinetic constants)
Highlight significant data; use bold type or a box on a figure, color on a slide

Line graphs: many points for one variable
Clear mathematical relationships (cautious about assumptions)
Often used for concentration or time dependence
Symbols need to be clearly distinguishable from the line and from each other; may use different colors if comparing multiple relationships

Histograms: testing only a few conditions
Comparisons of effects of different conditions

Visual data: autoradiograms, gels, photographs (cells, EM, *in situ* hybridization)
Models (structural or summary)
Most of us think in pictures -a picture is worth a thousand words, if you know what you're seeing.

Specific pointers for setting up figures

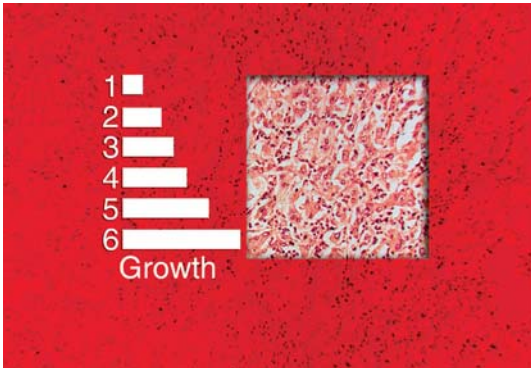
1. Use a title when possible. This is especially useful for slides. The best titles summarize the results in a few word.
2. Use side-by-side comparisons when possible.
3. Clearly label all data.
    - Panels should be designated, especially if there are more than 2
    - Use a number, letter or recognizable code for all lanes in a figure
    - May show only a selected field of data
    - May need 2 versions of figures, one for manuscripts, one for slides or posters, very expensive to publish color work; cheap to do color PowerPoint manuscripts; often use a,b,c,etc for lanes, but descriptors easier to follow
    - Use arrows or circles to denote something significant
    - Use error bars; denote statistical significance by a symbol or color

4. Size is important; check for visibility from the back of a room or standing in front of poster
5. Not too complex; watch overlapping symbols; colored lines and symbols helpful
6. Use colors that contrast well; avoid dark on dark (red on black) or light on light

Most labs have someone who is proficient in making figures on the computer. Graphics programs are updated frequently, so check on the programs of preference. Adobe PhotoShop is a current favorite.

If you need help, find a new friend, then do something nice for the person who helped you learn new skills. Make dinner or do a boring lab chore. Then teach someone else how to make great figures.

Many files are saved as jpegs, gifs or tifs and communicated through computers. USB compatible flash drives have transformed communicating even complex data. I carry multiple talks on a single mini-drive that is as small as a pack of gum. I can rearrange the files in minutes to create new talks, or update a talk minutes before I give it. There are still occasionally difficulties transferring data between systems, so plan ahead to be sure your presentation will work on the system that is available.



Chapter Eleven: Making Posters

Designing and creating a clear and informative poster is not only beneficial to those who examine it, but it is beneficial to you because it makes you stop and assess the progress and direction of your project. Keep in mind these tips when planning your poster:

Planning your Poster:

1. Think about your audience and their familiarity with the information you will present. The less familiar your work, the more background information and the less jargon you should include.
2. Think about your resources, including: past data, figures or photos, computer facilities and programs, the time you are able to devote, money you have available to use. Use already prepared material when possible, but credit those who created what you use.
3. Be concise and precise. Minimize words and use models and figures to their maximum capacity. You don't even need to use complete sentences.
4. Visual impact and aesthetics are very important.
5. Forget being subtle—clearly state your points.
6. You are trying to tell a story with the following elements:
   Title-informative and attention-getting but not cutesy
   Abstract-tell the story concisely: why, how, what were the results, what do they mean
   Introduction-describe the problem and your approach, clearly define your goals
   Methods-how did you do the experiments? Emphasize modifications to standard protocols, unique approaches. Include references to standard models.
   Results-the most important part, present your data in the most informative and easily understood format, the evaluation of your data should be easy to locate. You should present an interpretation of your data under the figure. Meetings are busy and the person you most want to have see your poster may very likely come when you're not there. Some posters are up for hours.
   Summary/Conclusions-summarize the essential findings and conclusion

Poster Preparation

1. Borrow, don't steal. Use photos and figures from other publications or people, but be sure to get permission to do so and cite them.
2. Size is important. Be sure the font is readable and clear (28 point size is good)
3. Neatness counts. You need: a paper-cutter, meter stick, art gum eraser or a computer.
4. Clearly label photographs and other data. Emphasize important points.
5. Mounting pieces separately allows maximum flexibility and re-use.
6. Think re-use. If you will use the same information or data for multiple posters, mount it on heavier grade poster board permanently. Some posters may be prepared as a single use sheet.
7. Always allow more time than you think you need. Plan ahead.
8. Have other's critique your poster. Can they follow the flow of information and do they get the major points?

Comparing Poster Formats:

1. **MOUNTED POSTERS:** components are mounted on poster board; often people use separate pieces, and even separate legends, for each panel
   Advantages:
   - Easily changed and updated
   - Cheaper than computer generated posters
   - Can rearrange the poster to ensure your information fits the space
   - Transport in suitcase or briefcase (if you mount in modular form)

   Disadvantages:
   - Preparation is often tedious and takes a long time
   - Setting up the poster can take from 15 to 30 minutes
   - More difficult to be as neat and precise with your formatting

2. **COMPUTER SHEET:** information is designed and prepared in PowerPoint as a single sheet and then printed out on a large sheet of paper (usually 3x6 ft)
   Advantages:
   - No mounting required
   - Easy to set up poster
   - Can make a mini-print out of poster to distribute

Disadvantages:

- More time to lay out on computer
- Cannot be changed once printed
- Must be printed on machine
- Expensive for single use; allocated for the poster
- Might not fit the space
- Transport case is sometimes awkward

Presenting Your Poster:

1. Develop a **logical layout** with numbers that guide a reader (and you) through the work.

2. Use only data you can defend or want to show or if you are presenting the poster in house to illustrate a problem you hope others can help you solve.

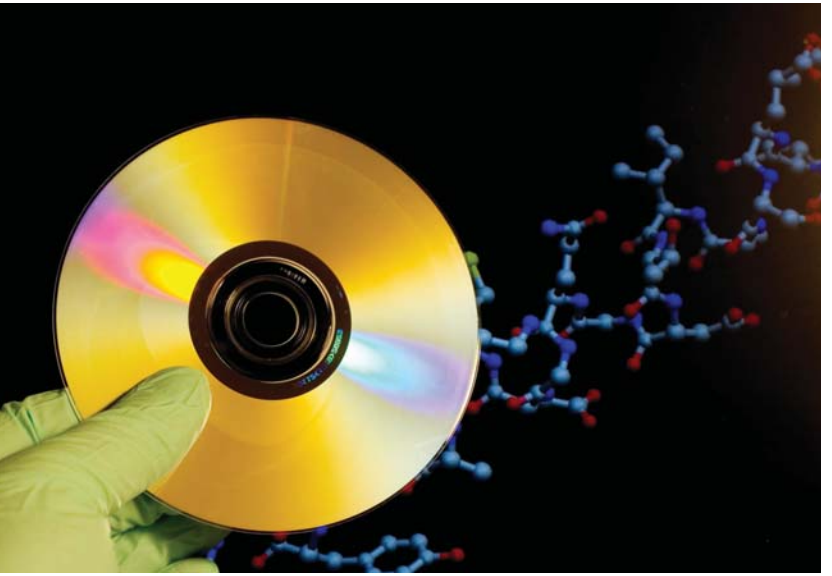
3. You need a **3-5 minute description** of your poster. Don't try to memorize a "spiel" but do plan what points you want to make.

4. Focus on the important points:
   - What is the scientific or practical reason for doing the work?
   - What are your goals, questions you are trying to answer?
   - **Briefly,** what are your methods?
   - What are your results? **Point to the data.**
   - What do they mean? Why are they important?

5. Interested people will ask questions about the details.

6. **Anticipate questions.** You know what you haven't done, yet. Present the poster to others in your lab and outside your lab to get feedback from people who are familiar with your work and those who are not.

7. **Get prepared.**
    - Get a drink of water before your presentation time or have a bottle of water handy.
    - Go to the bathroom before your presentation time (not a joking matter!).
    - Adjust your mental mood. Chill out if you're too nervous. Rev up if you're about to collapse because you were working at 2am.
8. Have some paper available to **take notes and write down suggestions** you receive or the names of people who have useful information - you may forget who told you the key to solving a problem.



How much can presenting a poster affect your career and life?

I met Wanda Vila-Carriles at her poster at a meeting her junior year of college. I was very impressed with her protein purification work. The University of Puerto Rico at Rio Piedras provides some wonderful opportunities for undergraduates to do research. I encouraged her to apply for the SMART Program. She would not only get to do terrific research, she could improve her English skills. Wanda did a fantastic job in the program. Then she used her SMART Program project as the basis for writing a successful fellowship proposal for graduate study. She didn't get the Ford Foundation fellowship, but she did get the NSF fellowship. And she used it to come back to BCM to continue her education.

As a Ph.D. student, Wanda initially struggled with classes, mostly due to language skills. Our IMSD grant (NIH GM56929) provided English language development and tutoring and faculty in her Molecular Physiology and Biophysics Department set up readings with her during which she would discuss papers in a one-on-one setting with faculty. Gradually, Wanda's English skills strengthened. Her science was already off to a great start. Soon after joining Joe Bryan's lab, she isolated more recombinant potassium channel protein in a weekend than everyone in the lab had isolated in two years. She created mutations for a structure/function study of this ion channel that is important in insulin secretion. Wanda was thrilled when she received perfect scores from both judges and won the Endocrine Society Award at a SACNAS meeting, but we were all ecstatic when she received the Young Investigator Award at the FEBS ABC Proteins Short Course in Vienna, Austria! How many Ph.D. students win an award as the best in the world in their field? All of the top guns autographed the book she received as the award winner. Her NSF fellowship ran out before she completed her Ph.D. project, so she applied for and received a NIH fellowship, which of course, included much more detail about her work than the shorter NSF proposal.

I'll never forget talking with one of the faculty members who worked with Wanda as she learned to read papers. He was still grinning as he told me about looking up and seeing Wanda sitting at the head table at a banquet of the editors and editorial boards of the journals of the American Physiology Society. Wanda was being "courted" as a potential post-doc by the chief editor for the journals of the society. He had invited Wanda to the banquet, picked her up in a limo, and introduced her to everybody. Dr. Reid said he finished the banquet and then realized he had to get something to eat. Every time he looked at Wanda, he smiled so much he didn't have time to eat. With Wanda's talent and perseverance and faculty who care that much about developing the next generation of scientists, it's no surprise that Wanda Vila Carriles, Ph.D. is maturing into an independent scientist that you will read about in the future.

Chapter Twelve: Oral Presentations

While public speaking remains the #1 fear of people, it will likely be something you will encounter in your scientific career as you are asked to present your research/work to different groups of people. Nervousness related to public speaking is not only prevalent in novice scientists, but it often affects experienced speakers, no matter how often they have to give presentations. However, everyone can improve their effectiveness as a presenter of scientific information with proper assessment and practice and even become more comfortable speaking for groups of people. Many people benefit from attending Toastmasters' Groups where you can learn and practice presentations skills in a gradual way with others who want to improve their public speaking skills. You'll even meet interesting people.

General Pointers for Effective Speaking

1. All talks are persuasive in nature although with some talks it is more obvious. The level of emotion you demonstrate in your presentation will vary depending on the type of talk and the audience.
2. Different talks have different goals. Know what effect(s) you desire to elicit: communicating knowledge, swaying an opinion, encouraging an action.
3. Your talk must be developed for the audience and setting. Knowing the age, size and familiarity of the audience helps you assess the content and style of your presentation.
4. Different presentation styles are effective with different audiences
5. If the talk is long, 30-60 minutes, use a variety of visual aids or approaches.
6. You need to know what you're talking about, but you don't need to have all of the answers.
   Acknowledge when you don't know something; don't apologize.
7. Pay attention to timing. It is rude and unprofessional to go overtime, except in unusual circumstances.

A Very Long Talk – A Very Receptive Audience

When Carlos Bustamante, Ph.D. presented a talk on using molecular tweezers to study the structure of a functioning RNA polymerase at BCM, the audience was enthralled. He logically explained complex experiments and results in terms people could understand. His slides and videos were informative and eye-catching. People were so excited about the work that they kept interrupting him with questions, which he patiently answered. About 50 minutes into the talk, he turned to the audience and said, " I'm running behind. I want to share more of this story with you. The seminar may run overtime." Everyone nodded and said, "OK". Only two people had to leave, everyone else stayed until he finished the story twenty minutes after the seminar was supposed to end. Then he had to wait for the applause to die down. When he spoke at the 2004 ABRCMS the undergraduates and faculty were on their feet cheering before he finished the talk. One faculty member said, "If that doesn't get you excited about science, nothing will!" We have stars in science, too. They do great science, sometimes using high tech physical techniques to answer biological questions and have a flare for explaining their work in understandable, exciting terms. Thanks Carlos!

Common Components of a Scientific Presentation:

1. Discuss the focus of your work in general terms
2. Present the background of your lab, including pertinent past research results.
3. Highlight your aim, or the question you are answering (this may or may not be in hypothesis form).
4. Discuss your approach to the problem, often including a word slide or flow diagram to illustrate the general steps of your project. Avoid unnecessary details but be specific enough to allow the audience to appreciate your work.
5. Present your results, show some data and present graphs or tables to summarize multiple observations. Use statistics, if appropriate. Be sure people get a sense of how much work went into the study. How long did it take to make the DNA construct? How many different designs did you have to test to get the instrument to work? How many different photos did you examine looking for a new star? How long did it take to write the computer code that lets you visualize a virus in 3-D space?
6. Explain your results. The detail you include will depend on the time allotted for the talk.

7. Identify problems that arose and how you dealt with them.
8. Summarize your conclusions or observations.
9. Discuss the conclusions you were able to draw and mention the direction the research is heading. Propose, in general terms, experiments that might be done to further your work, with your mentor's ok.

Preparing a Scientific Presentation:

1. Planning is important.
2. Decide on the key point(s) and build the talk around it (them). Your points do not have to be in chronological order. Remember that you're telling a story so make the presentation logical and easy to follow.
3. Acquire information that supports the point(s).
4. Organize information in an effective way. Using note cards, or a computer can be helpful.
5. Produce an effective summary of information using word summaries, models, graphs (generally easier to read than tables) and pictures. Presenting a model with question marks on what you don't know at the beginning and closing with the model with new info highlighted can be very effective.
6. Decide on visual aids that are appropriate for your audience, information, budget, and resources. Some common aids are: handouts, photographs, slides, transparencies, PowerPoint presentation with or without video, poster, chalk or marker board.
7. Write out the talk, especially if you have a tight time frame or you're really nervous.
8. Practice your presentation both to yourself (looking in a mirror) and with a friend, those who can provide critique.
9. Revise your talk to improve rough spots.
10. Prepare an easy to follow written format and use a font that is easy to read.

Preparing Effective Speeches

1. Have something significant to say. Even if you don't have results, you can still convey important information to your audience.
2. Organize information logically.
3. Emphasize important points vocally and with phrases that draw attention.

4. Start with adequate background material.
5. Explain what you are doing and why you are doing it or want to do it.
6. Use visual aids effectively and point out points the audience might miss. Effective visual aids are: large enough to be seen, complete, but not too busy, clearly labeled, colored effectively (in a manner that clarifies data instead of obscuring it).
7. Avoid excessive repetition.
8. Use analogies that people can understand.
9. Re-summarize important points or conclusions.
10. If you are showing a printed copy of the summary or conclusions, use the same wording so people can follow along.
11. Allow time for questions. Try to anticipate questions and prepare answers.

Effective Presentation Skills

1. Speak clearly and speak at a speed that is understandable.
2. Use an appropriate volume that is loud enough without screaming. Request a microphone, if needed, and test it before you begin.
3. Get familiar with lighting controls and AV equipment ahead of time; especially if you are using video or Powerpoint.
4. Decide if you will sit, stand or use a podium (often decided by the size and style of the audience). Use a podium if you are unfamiliar with material and need to refer to written text often or you are so nervous you really need to hold onto something. That's OK.
5. Use pointers effectively, especially when the audience is not familiar with your data. Point to bands on gels, areas on photographs, parts of a diagram, etc. that are difficult to describe. Be careful to not overuse pointers; you can make people dizzy.
6. Be careful of using distracting mannerisms, like playing with your hair, pacing, saying "uh…", gesturing too much with your hands.
7. Look at the audience. Make eye contact with a variety of people, unless you are very nervous in which case it helps to look at one "friendly" listener.
8. Use humor only if appropriate and you can carry it off well. Be cautious about using jokes that don't fit or insult your audience.
9. Avoid coming across as a snob, as overly apologetic, or as belittling.

10. Acknowledge help within the constraints of time. You can always include a final slide that lists the people involved in the project and acknowledges the funders of the project.

Mentally Preparing for a Presentation:

1. Be aware of the mood you want to create: professional, reconciling, encouraging.
2. Be aware of your mental status.
3. Match your mental status to the mood you need. Relax if you need to be soothing; "rev up" if you need to be stimulating. Use mental images that help you adjust your mood.
4. Visualize a successful presentation.

Chapter Thirteen: Attending Conferences and Networking

Your talent, knowledge and work are your most important assets, but the connections you make with other people can be very important to your career advancement. An excellent letter of recommendation or personal appeal for you can make the difference in getting a fellowship, grant, award, job or promotion. Getting to know people isn't that hard and useful connections are often formed instantaneously! Some connections take more time to develop.

Meeting other scientists/engineers:

While many of these connections will be made as a graduate student, you might get a head start on networking as an undergraduate.

- Other faculty, not just your advisor
  - Get to know your advisor's collaborators, if possible
  - Get to know the faculty in your department
  - Meet faculty at retreats, parties, seminars, own labs
  - Meet other faculty who work in areas in which you are interested
- Post-docs, grad students, collaborators often network with each other
- Seminar speakers
  - Go to the seminar
  - Ask questions, even privately
  - Go to arranged luncheons/dinners
  - E-mail contacts after the visit

Making contacts at conferences

Undergraduate research conferences often include exhibit booths from agencies or graduate/professional schools that provide excellent opportunities to network with people who can make a difference in your career opportunities.

- Depending on the size of the conference, you will want to use different strategies for meeting people.
- Get the program and abstract book ahead of time; target contacts

- Do your homework; read some papers or check out websites before the conference
- Go to talks, posters or exhibit booths of people you want to meet
- Ask an intelligent question
- Try to get your advisor or someone to introduce you to people who are less approachable
- Try to meet people one-on-one or in a small group
- Use free time well - go with a group to climb White Mountain or go sailing
- Know when to give up on meeting someone; Nobel Prize winners are tough
- Contact people directly even if you haven't met them: email, phone

Make a file on people

- Area of interest, contact information - email
- Others who know them
- Personal interest or hobbies; sailing, skiing or tennis, etc.
- Follow-up: e-mail, card, note about their presentation or an idea
- Connect before the next meeting; arrange to see them

People with whom to make connections

Officials at research programs or graduate schools you want to attend; agencies or businesses where you want to work or study

- Leaders in the field (grant or manuscript reviewers; conference organizers)
- Future collaborators
- Future mentors
- Future co-workers; interview for jobs at some conferences
- Friends, supporters

Pointers for Networking:

1. Gauge the situation: formal, casual, down-right rowdy - react appropriately
2. Personalities of people you need to know vary widely from nice to real jerks
   Many scientists are shy; you need to make the first move; watch being pushy
3. The best connection is often the science, but not always – it may be a hobby

4. Approach people
    - Speak clearly
    - Good opening: "I really enjoyed your presentation on....
    - Make a specific comment about the work if you can.
    - Comments don't have to be positive, but word criticisms carefully.
    - Introduce yourself with your name, lab and where you work.
5. Be a good listener
    - Almost everybody likes to talk about their work or ideas.
    - Pay attention and ask questions for clarification.
    - Be cautious about interrupting to show off.
6. Contribute something to the conversation
    - Share ideas (but use discretion, don't leak something you shouldn't).
    - Some effort may be needed to get a word in.
7. Strengthen relationships with people you meet - suggest another meeting
    - Don't get your feelings hurt if they can't meet with you.
    - Realize that it may take effort, or be impossible, to develop a connection.
8. Follow-up after meeting people; email, phone, card, send info
9. Find a way to remember people you meet - associate their name with something to create a link in your memory.

Chapter Fourteen: Grad School Applications

Preparing and submitting a successful graduate school application is an integral part of your admission to a graduate school in the sciences/engineering. It can be stressful! However, armed with a few practical tips and helpful hints, not only can you prepare an impressive application, but you can gain confidence that it will help usher you into a successful career in science/engineering.

First Steps Toward a Successful Application:

1. Do your research on various programs, what they have to offer and what they look for in prospective students. Ask for advice from mentors, graduate students, and other professionals in the field. Check out websites through entering names of school, or try http://www.gradschools.com. Visit each program's website and contact the program director, faculty members and administrators to ask questions.
2. Consider a variety of facts in narrowing your choices of schools to which to apply:
    - Your research interests versus projects available and environment
    - Quality of mentors and resources available
    - Requirements for admission
    - Environment for students (Ask current graduate students. Programs should help you contact their students. If they don't want you to talk to their students, do you really want to go there?)
    - Location and quality of life issues, cost of living relative to stipend, sources of financial aid, housing (May need to consider family and relationships)

All good US Ph.D. programs in the sciences and engineering will provide you with a stipend/salary. You contribute to the baseline of knowledge while you gain your advanced education. Most Ph.D. students without children or spouses to support can live on the stipend/salary paid by their schools. Low interest loans are available. NIH *(http://www.nih.gov)* has established loan repayment programs for those with terminal degrees who conduct research. Some fellowship programs provide generous stipends for Ph.D. students *(http://www.nsf.gov)* and some graduate schools even provide additional salary to graduate students who are awarded nationally competitive fellowships.

3. Select between 4 and 12 schools to which to apply. Include a variety of schools, including those to which you feel certain you will be accepted and some that you are not sure will accept you. American educated students are in greater demand than you might imagine.
4. Acquire applications from websites or by mail. Request application fee waivers, if you need to do so. Many programs waive fees for on-line applications.
5. Create a file for each application. (Paper or computer files work, but realize that you may receive some paper communication from some schools). Include a spreadsheet with deadlines and requirements and check it off as you submit your applications.
6. Get a copy of your transcript for your own use.
7. Prepare an outline of your accomplishments and a draft of your personal statement and research experience, including your skills, work experience, and the obstacles you might have overcome to get an education or in life.
8. Take the GRE early enough to ensure that you can re-take it if necessary.
9. Meet with a trusted faculty member who can help you evaluate your progress and give you advice on your strengths, sometimes point out your weaknesses.
10. Request letters of recommendation from people who can evaluate your suitability for graduate study. If you have done research or work related even vaguely to your field of study, get at least one reference from your mentor or supervisor. Multiple references from people who were mentors are even better. If you have not become acquainted with professors in advanced courses, do it now! Letters from a teacher in a 300 student organic class mean very little, unless the teacher knows you well. Many graduate schools outline the characteristics they want recommenders to address in their letters, which you can provide. Give those writing your letters outlines of your accomplishments. Provide information on deadlines, stamped addressed envelopes or information on how to submit letters electronically.

Graduate School Application Pathway

1. Applicant obtains application (paper or web-based)
2. Applicant completes application and requests all materials be sent
3. Clerk begins a file that a program director or administrator may review

4. Applicant follows-up with the program to ensure that all components have been received. This is your responsibility. Ask if there is any additional information the program would find helpful.
5. Depending on the system, the file will go to a specific program or members of the Graduate School Admissions Committee. Files will usually be reviewed by several faculty or committee members. Additional information may be requested and the applicant will either be rejected, deferred or invited for an interview.
6. Applicant will be contacted to arrange interview (may be over the phone).
7. Interview will be held, generally with several other candidates.
8. Applicant will be ranked by interviewers.
9. Committee will meet to discuss candidates and make a recommendation to accept, defer or reject the applicant.
10. The evaluations will go to the Graduate School Admissions committee that will review the applications and recommendations and make the final decision regarding acceptance.
11. Clerk will validate all transcripts and letters of recommendation.
12. Clerk will send letter of acceptance or contact the applicant by phone.
13. Applicant responds and discusses any pertinent issues.
14. Applicant decides whether to accept the offer and notifies all schools where accepted of the decision immediately. There are always alternates who want the spot you didn't accept. Most US grad schools adhere to an April 15th target by which to finalize decisions, but if you decide sooner than that, please let everyone know.

Graduate School Application Components:

1. **Application forms:** Specific forms are filled out for each school to which you apply. They are often submitted electronically (check out the program's website). The application form generally includes a personal statement of goals and preparation for graduate study.
2. **Transcripts:** You will need to submit an official transcript from any college or university from which you have received college course credit.
3. **Letters of Recommendation:** These are a critical part of your application. Be sure to choose individuals who are acquainted with your potential, abilities and accomplishments, who have known you long enough to write with authority, who are familiar with your educational and ca-

reer goals, and who will write favorably about the skills and talents you possess that make you a good candidate for graduate school. Prepare a list of accomplishments that you can send each recommender and a list of the graduate schools and their deadlines for application. Also include a stamped envelope addressed to the graduate program, unless the letter is to be submitted online. If it is an on-line submission, send the directions for submission.

4. **GRE Scores:** Scores from the Graduate Record Examination are required by most graduate schools. Most schools require the general GRE, some require the general GRE and a subject GRE in a field related to the proposed field of study. See chapter two for a more extensive overview of preparing for doing your best on the GRE.

Writing A Personal Statement:

The personal statement is your chance to help reviewers get to know and understand who you are. It should reflect your experience and character.

1. You should include your motivation for doing science/engineering, your areas of interest (mention faculty members by name), your goals, and your preparation for graduate school. Write about your research /work experience and your accomplishments.
2. Describe your advanced coursework. Explain any science/engineering grades that are below a B. What have you done to insure that you learned the material covered in courses for which you made grades below a B? Did you make an A or B in a more advanced course? Did you do independent reading or a project that strengthened your background?
3. Discuss other activities that are relevant, and show your independence and sense of responsibility. However, do not include a wide range of community service activities and club involvements. Only include those that are relevant to the areas you want to pursue or show your ability to function independently or responsibly.
4. Be sure to adequately explain any unusual circumstances. *Do not raise any issues you don't want to discuss.* Your application may be strengthened by discussing obstacles you have overcome in life. There is a difference between an excuse for performance and an explanation of situations you have faced. Yes, it matters that you have funded your entire college education by working while you took classes. Dropping a class after you broke your leg is understandable. Dealing with family illness may be relevant to your motivation and academic history. But, be

cautious about mentioning issues you don't want to discuss. Once you raise an issue, it becomes a fair topic for questions.

5. Watch your adjectives—one word can change the whole impact. Words like "passion", "thrill", "committed" have their place in a personal statement, if your actions backup your claims. Make sure your description of yourself matches the facts. For example, don't say, "I have excelled academically" when your GPA is a 3.0. (Yes, a student did say that, which related a lack of understanding of the standards of Ph.D. programs.)
6. Check your grammar and spelling and make sure to use active voice sentences (I completed…, I conducted…). Get help with grammar if you need it, but pay attention and learn from the input you receive. Don't just rely on someone else to fix your mistakes. Make sure it is clear what you have done, learned.
7. Have others (including faculty members) critique your personal statement.
8. Revise, but don't obsess over writing a perfect personal statement. Your goal is to write an essay that can be accurately understood. The essay should be your work, clarified by comments from others. A major reason they added the analytical writing component to the GRE is because so many people had so much help in writing their personal statements that graduate faculty were very disappointed in the discrepancy between writing on the essays and writing performance in graduate school.

Describing Research/Work Experience(s)

The description of your past research/work experience is a very important part of your application to graduate school and can help you on almost any application. Take the time to write a thorough and unambiguous description of your experience(s). If you have multiple real-life experiences, you may want to list them, but then focus on one that is the most relevant to the program to which you are applying or that shows your greatest level of achievement or independence. You may need to refer to notes or abstracts to refresh your memory.

1. What do graduate schools want?

- Concise (usually no more than one to two page) description
- Evidence that you understood the project. Include the significance of the work, the goals of the work and how your contribution related to the goal.

- What you learned, without philosophizing. Just explain what you did.
- Examples of techniques/procedures you used and your familiarity with them

For example: A description might start with, "As a consequence of my studies of gene expression during spermatogenesis, I have a better understanding of how to extract RNA from cells and conduct hybridization experiments, including *in situ* hydridization. I developed light microscopy skills and improved my knowledge of basic statistical analysis." Then expand the description to include more detail. The right details will earn you bonus points-the sizes of DNA fragments; the restriction sites; the sensitivity of an assay you develop, the type of computer language used in your program.

Results, including publications and acknowledgments, if any.

2. Practical Pointers for Describing Research/Work Experiences

1. Check your general statements for accuracy and add appropriate qualifiers.
2. Include an appropriate level of sophistication. Avoid elementary explanations (people know what a DNA double helix is) and define abbreviations, except extremely common ones. Pay attention to your audience and include details that illuminate the depth of your understanding of the project.
3. Avoid empty phrases that convey no information ("was changed").
4. Avoid negative words, ("failure", "inadequate", "disappointment").
5. Avoid overstating the case ("radical discovery", "revolutionary").
6. Emphasize the positives of your work, even if that was showing that a hypothesis was wrong or that a specific approach wouldn't work. Real science includes finding "dead-ends". You usually learn more when things don't work, than when they do.
7. Get updates from those with whom you worked. Did they follow-up on your project? Did your work enable others to make discoveries or accomplishments? Were your results or techniques used as the foundation for a grant or proposal?
8. Have others read your research description. Can they understand your points? Revise accordingly.

Impact of Research Descriptions

Your research/work description can make or break your graduate school application. Having excellent grades won't matter much to a reviewer if you write three sentences about your research/work experience. Don't laugh – I've seen students who submitted no more than a few nebulous lines about their research. Even if your mentor has great things to say about your work, you need to convey what you did, what you learned, and what it meant.

I know of cases when a student's grades were less than stellar and GRE scores were not strong, but whose research description was so strong and reflected such interest and commitment that faculty took the time to read letters of recommendation carefully. One such student was invited for an interview and wowed everyone. Her knowledge and enthusiasm were evident. The program decided to give her a chance. Once she was taking courses in the field she loved, her grades improved, her research was outstanding, she received a national fellowship, and became a leader in her Ph.D. program. She was not only selected as her program's most outstanding Ph.D. student, she received the award as the most outstanding Ph.D, student in the entire graduate school of nearly 500 students. Without a strong research description, the grad school that became the home in which she could develop so completely might not have given her the chance to "sell herself".

Chapter Fifteen: Grad School Interviews

Purpose of Graduate School Interviews

Choosing students to be admitted to a graduate program in the science or engineering fields, especially a Ph.D. program, is an expensive decision. It costs about $250,000 to educate a Ph.D. student in the biomedical sciences. Choosing a graduate school is a major decision for the student and the program. Good graduate schools interview their applicants before making a decision about admissions and want students to become familiar with their school before deciding to accept an offer. Most good graduate schools will fund the interview trip. The extent of the interview varies with schools. In unusual circumstances, particularly if the trip will be very expensive, the interview may be held by phone. Be cautious of any program that accepts you based only on the application, especially if they want you to make a decision without visiting the campus. If you participated in a research program at the graduate school, everyone may feel that there is enough familiarity to make an informed decision without an additional trip, but realize that situations may be very different at different times of the year, especially with respect to the weather. Some areas are beautiful during the summer research program, but a different world in the winter when graduate school interviews are usually held and when you will live for three to five months each year.

Helpful Hints Before the Interview

No matter how excellent your paper application is, an impressive interview and a memorable, positive impression increase your chances of being admitted to the graduate school of your choice. This is your chance to bring your application to life and directly communicate to the faculty your strengths and abilities with a special uniqueness that will make them remember you. However, remember that your interview is a professional, encounter, requiring that you present yourself as a competent, responsible and well-mannered adult. Here are some tips to help you get through the entire interview process as smoothly as possible.

1. Do your homework! Make a “cheat” sheet with information about the program, including size, mentor names, special courses and format. Note faculty who do research in areas in which you are interested and know some information about the program director. Find out who your interviewers will be, if possible, and check websites for information on their research and background.

2. Prepare a statement, but don't rehearse it like a script. Do a few "mock" interviews with faculty from your own school. Be sure they give you feedback on whether you are answering questions clearly and appropriately.
3. When you make travel arrangements try to get good airfares and if something arises that will change your schedule, contact the program as soon as possible. It is expensive to bring students in for interviews. Programs will appreciate your attention to their budgets.
4. Pick out, purchase or borrow clothes that are neat, comfortable and professional but less formal than a suit. Make sure to wear shoes that are adequately broken in and comfortable. Don't hesitate to borrow things from someone. You may not own a winter coat, gloves or scarves. Most interviews happen after the holidays. Give friends and relatives a "wish list" of what you might need for interview trips.

Three students from a west Texas campus were selected to interview for medical school at BCM. The Dean of Admissions felt it would be thoughtful to schedule them for the same interview date, so they could share a ride. The students responded, quickly, that they wanted to interview on different weekends. The Dean thought this was unusual, but honored their request. An astute interviewer noticed that the suit, (which is obligatory for medical, business or law school interviews), worn by one student fit, was too big for one student and too small for another. Yes, it was the same suit. So what happened? All three were academically acceptable. All three were accepted. Students who were willing to help each other that much, displayed important characteristics that one wants to see in physicians. (Gas prices were cheaper then. Today you could buy a suit for what it costs to drive from west Texas to Houston.)

5. Send any information that has been updated since you filed your application, including publications, awards, or presentations.

Helpful Hints During the Interview

1. Be your professional self. Avoid profanity, rudeness, or distracting mannerisms.
2. Listen carefully. Wait to hear the whole question before you answer.
3. Gauge the length of the required answer. Answer it as to-the-point as possible, but look for opportunities that open the door for you to discuss the points you want to bring up.

4. Be sure to emphasize your strengths and experience.
5. Don't try to "bluff" or pretend you know answer to questions. It's okay to say, "I don't know" but, finish with a comment regarding what you might do to find the answer.
6. Be ready to discuss your research/work in terms of what you did and why it was (potentially) important. Let you enthusiasm show; if this is very difficult, you can mention how much you worked as an example of commitment.
7. Comment on the interviewer's research, if possible. Ask questions, make comments. go beyond, "That sounds interesting." If you raise questions about or criticisms of the work, be professional and polite.
8. If you know the interviewer, don't assume too much familiarity, but don't be surprised if the atmosphere is slightly more relaxed. If you had a previous conflict with the interviewer, contact the program director to explain the situation. Request a change in interviewer, if necessary.
9. Be honest, but you don't have to reveal personal information, unless you raised the issue (like martial status, parenthood, illness) in your application. It is illegal to ask questions that reflect discrimination. My personal opinion is that being honest about personal situations from the beginning is the best policy. Some schools will make great effort to accommodate children or personal circumstances, or have excellent resources for those with physical challenges that go beyond the accommodations required by law. Don't you want to go to the place with the best situations to help you be the most successful? Some schools may not have dealt with specific circumstances in the past, but are willing to do so. No one can help you overcome a problem that you won't discuss. Many successful people have overcome great obstacles in life, by accessing help and persevering toward their goals.
10. Be prepared to ask some questions about the program or graduate school.

Overcoming Shyness in an Interview Setting

Shyness is one of the behavior traits strongly correlated with genetics, but this does not mean an introverted personality has to interfere with your interview. Many excellent scientists are shy people, but they learn to communicate adequately with others. Many of our student have benefited from attending Toastmasters' Groups where people gradually present talks before groups of others who want to become

more comfortable speaking. Here are some tips for shyer people or those who are uncomfortable talking about themselves.

1. Have a trusted faculty member review your accomplishments and help you identify your strengths, abilities and unique experiences. Provide them with the information they will need to bring out the strongest parts of your application.
2. Do "practice" interviews with several people. Ask them to increase the intensity of the interviews as you get closer to the real interviews.
3. Make "cheat sheets" with important information about the school and yourself, and review them before the interview starts.
4. Be as prepared as possible: this increases confidence.
5. Adjust your mental attitude as your enter the interview. (See the pointers under "Psyching Up to Succeed", in chapter two.)
6. Don't let tough questions frighten you. Do the best you can to answer even difficult questions. Realize that everyone has limits. The interviewer may be trying to find your limit. I'll never forget talking with an alumnus of our SMART summer research program about one of his interviews. The interviewer challenged every statement he made. She really pushed hard to see how he would disagree with her. The interview even extended to twice the allotted time. How did she score him? Apparently very well. He was accepted and matriculated there.

Sample Interview Questions:

Although the wording may vary, many interviewers will ask questions relating to these themes.

- Tell me about your previous (research/work) experience.
- Why do you want to go to graduate school? Why do you need a Ph.D.?
- What are your long-term goals?
- Why do you think you will be successful in your chosen career?
- What experiences have prepared you for graduate school?
- Why are you interested in our program?

- What projects attract you for dissertation research and why?
- What areas do you think you need to strengthen? (If there are obvious areas from your application they may ask about them specifically.)
- How do you deal with people who are different from you?
- What do you think will be hard about graduate school?
- What have you not told me you want to be sure I know?
- What questions do you have about… our program, my research, etc.?

Remember: **Your goal is to relate your interest in and preparation for graduate study in a professional, confident but realistic way.**

Social Events as a Part of the Interview

Some interviews include meals or other activities with students or faculty. Science is a collegial endeavor. Engineers work in teams. You may be shy but you need to demonstrate that you can interact with others. These activities are important, but are usually more relaxed than interviews. But people will probably provide feedback on your participation in the events.

1. Attend all "interview" events, even if you are in your home-town. You can provide useful information if you are a local student. I know students who were not accepted by graduate schools because they used the interview weekend to meet with friends or family and ignored program activities. They left people with the impression that they didn't want to connect with those in the program. Science is very collegial. Engineering projects often involve teams of people. Interviewers want to know how you would interact with co-workers.

2. Use these events to get to know people. Even shy people can find something to talk about, even if the question is, "What is your research topic? Did you learn a lot from courses?"
3. Realize that there will be feedback on your behavior and interaction with others. This is not the time to get drunk, curse or act like the life of the party. Avoid skimpy or revealing clothes, unless you're at a beach party, even then dress appropriately for the occasion.

Comments and Behaviors that May Torpedo Your Interview: What to Avoid

1. Arrogance: Everyone with whom you interact is probably bright, whether it is obvious or not. Acknowledge opportunities you have had to develop your skills and knowledge, but don't be overbearing about your qualifications.
2. Lack of Communication: People can't read your mind. You must tell them about your interests, accomplishments and goals. You will also be expected to ask some questions. I know students who were not accepted by programs where they had done successful research because they were non-communicative during the interview.
3. Lack of Interest: This often comes across as belittling the program. You may be pleasantly surprised by what you learn at any point in the process. If people think you aren't interested in the program, they will not want to waste a position on you.

Avoiding A Misunderstanding About Your Interest in a Program

Some situations become heart-breaking. I was delighted when a wonderful SMART summer undergraduate research program alumnae was invited for an interview by a very competitive program. She had expressed her intense interest in the program to me and to others. After her visit, people who met her commented that she just didn't seem interested in our program. I talked with program administrators and expressed surprise at the conclusion. I was discouraged from contacting her to discuss the issue. Regrettably, I listened to them. Eventually the program made her an offer, but we were too late. She had already accepted another offer. I later learned that she had been sick during the interview weekend, but didn't want to cancel because she really wanted to come to the program. Better communication may have resulted in a different outcome. I know the program she entered has benefited from her participation – but I really miss her!

4. Negative Comments about Others : You may have had conflicts or complaints about your school, but if it is necessary to discuss these, do so in a professional way. “Dr. X and I disagreed about the interpretation of my results”, or “I would have taken a more advanced genetics course, had it been available at my college.”

Helpful Hints After the Interview

1. Send a follow-up thank you note or email to people who were helpful.
2. If you really want to be accepted, contact the program director or administrator expressing your interest.
3. Send additional information if requested.

Chapter Sixteen: Choosing the Right Graduate School for You

If everything goes well, you will be accepted to multiple graduate schools and be faced with making the decision about which school is right for you. Sometimes the choice is easy – one place just seems like the best for you. In other cases you may feel very torn between different options. There may be many factors to consider in making the choice. Most of the time, no situation is perfect and you have to decide which factors matter most to you. I like to write down positives and negatives and give each factor a weight related to its importance. Some of the factors you might want to consider include:

1. Research interests and environment

- Projects that match your interests; good, highly respected mentors
- Avoid choosing a school because of one faculty member. Anything could happen to that one mentor – move somewhere you don't want to go, lose their funding, even die suddenly.
- Core facilities to do routine work (histology core, sequencing core, protein analysis, microscopy capability, fermentors, etc). Animal facilities may be important to your work, even if you don't think so now.
- Student publications; career outcomes (Do they match your goals?)
- Friendly? Open, ease of collaboration?
- Welcome diversity
- Reputation of the graduate school or program; realize that reputations are often based on research productivity of the faculty with little or no input regarding the situation for students.

2. Course options:

Rigid or flexible; types of courses; breadth and depth; institutions at which courses can be taken without paying tuition

3. Your preparation for success in the environment.

Will you feel like the weakest student in the program? That maybe OK, if you are prepared to deal with the blow to your ego and really want to go to the school. Some of the students who struggled the most at BCM became our best researchers. But, you want to go to a grad school where you are surrounded by challenging students. The way to improve at any sport is to practice with players who are better than you are.

4. Professional development opportunities

- Journal clubs, seminars
- Skills workshops; help with posters, talks, fellowship applications
- Day for students to present research; get feedback
- Departmental retreats or student days
- Travel to conferences

5. Environment for students (need inside information):

- Own impressions of dealing with program and students
- Were you allowed to interact with students in an open situation?
- Consistent financial support for students
- Support network (people, tutoring, counseling, organizations, English skills development)
- Presence of post-docs from whom you can learn
- Library and computer access
- Transportation, parking, housing, safety
- Emergency loan program
- Opportunities to broaden your experiences (internships in biotech, law, teaching, with engineering firms)
- Career counseling, career workshops or help with placement

6. Quality of life issues

- Family and relationship issues (job for partner)
- Salary relative to cost of living; shopping options
- Climate; hot/cold?, rainy?, hilly?
- Your interest in other activities: sports, arts, music, places of worship

In the end, it is your life and your choice about where you will spend critical years of your education and development as a scientist or engineer. Where can you make the most of the opportunity to reach your potential? The knowledge you amass, the skills you learn, the discoveries you make, the career you develop will take you to places you can't yet imagine. You can enrich your own life, that of people who are close to you and even the lives of people you will never meet. Scientists and engineers and those who are both, contribute to making the world a better place for everyone. Good luck, learn something new every day and pass on – pass forward some of what you learn every day!

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