How to Succeed in Grad School:

maximizing your grad school experience

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What's "Success"?

Operational: the ability to graduate and move on to the next phase of your life (with choices!) with all of the skills you need -within a reasonable time frame (4-6 years)

What's "Basic" (Common)Success?

- One good publication, in a specialty journal
- 3.0 GPA in graduate school
- Mastery of bench science
  - Mastering specific techniques in your field and peripheral but related fields
  - Experimental design- some independence and someanalytical skills
- Ability to communicate: write proposals and papers, give talks
- Acquisition of people resources (network) and information resources
- Two good recommendations from faculty familiar with your work

What's "Excellent" Success?

- Three good publications (on important topics, in widely-read, higher impact journals)
- Complete mastery of bench science
  - Independence at the bench; ability to design new projects from the literature
- Complete mastery of a field
- Excellent ability to communicate: to write proposals and papers, give talks, work with others
- Honors- grants, awards etc
- Stellar recommendations (top 5%) from three or more faculty familiar with your work

How to Succeed?

- You must connect your stated goals with your actual effort
  - There are hundreds of applicants for every assistant professor position
  - Biotech companies want the same excellent credentials as academia
  - Your competition will have those credentials
- There is no substitute for hard work
  - Most successful scientists say they put in 50-60h weeks as students
- If it *always* feels like work, this may be the wrong job for you!

Personal Qualities Required for Success

- Passion for science, enjoyment of intellectual challenge, viewing bench science as "fun": CURIOSITY
- Tenacity, persistence= DRIVE
- Ability to visualize and work for a long-term goal (drive to finish): VISION
- Positive outlook
- Vast intelligence and brilliant coursework are less important than the above qualities

This Presentation

- Efficiency at the bench
- Obtaining, organizing, and presenting information
- Maximizing your grad school experience

The Bench

How to Succeed?

- While you need to have a hypothesis, much of science is just luck
- You can get lucky if you try A LOT of different experiments
- As you mature scientifically you will be able to run several projects concurrently (and test many effects in a single experiment)
- Increase your odds of being lucky!

Maximizing Efficiency at the Bench

- Start with a daily list
- Prioritize this list: do the *most important* things first
- Interleave items so that the most jobs get done
- Plan for the next day's work before you leave
- Work on at least one weekend day (this will save you months!)
- Read literature mostly at night
- Put a date on EVERYTHING! It's a locator device.
- Watch out for inefficient use of computer time

Always Do Feasibility Estimates

- Many experiments (especially assays) benefit from a preliminary calculation prior to starting
- These estimates need not be exact- ballpark it!
  - A band on a gel like the standard is 2 ug. What is your yield of protein?
- Saves time!

Experimental Design: Thinking *vs* Doing

- Think about the figure in your eventual paper
- Run all appropriate controls and standards together with samples
  - The sample is always in the middle of the standard curve!
  - More controls are better than fewer
- Think as much as possible about potential sources of error and ambiguity in interpretation ahead of time

Experimental Analysis

- Be your own worst critic: do the right number of replicates you need (or more)
  - If error bars overlap, are results really significant? What does a power analysis show?
- Is this a generally accepted method in the field?
- Is there any way you could have obtained your results through any kind of an artifact?

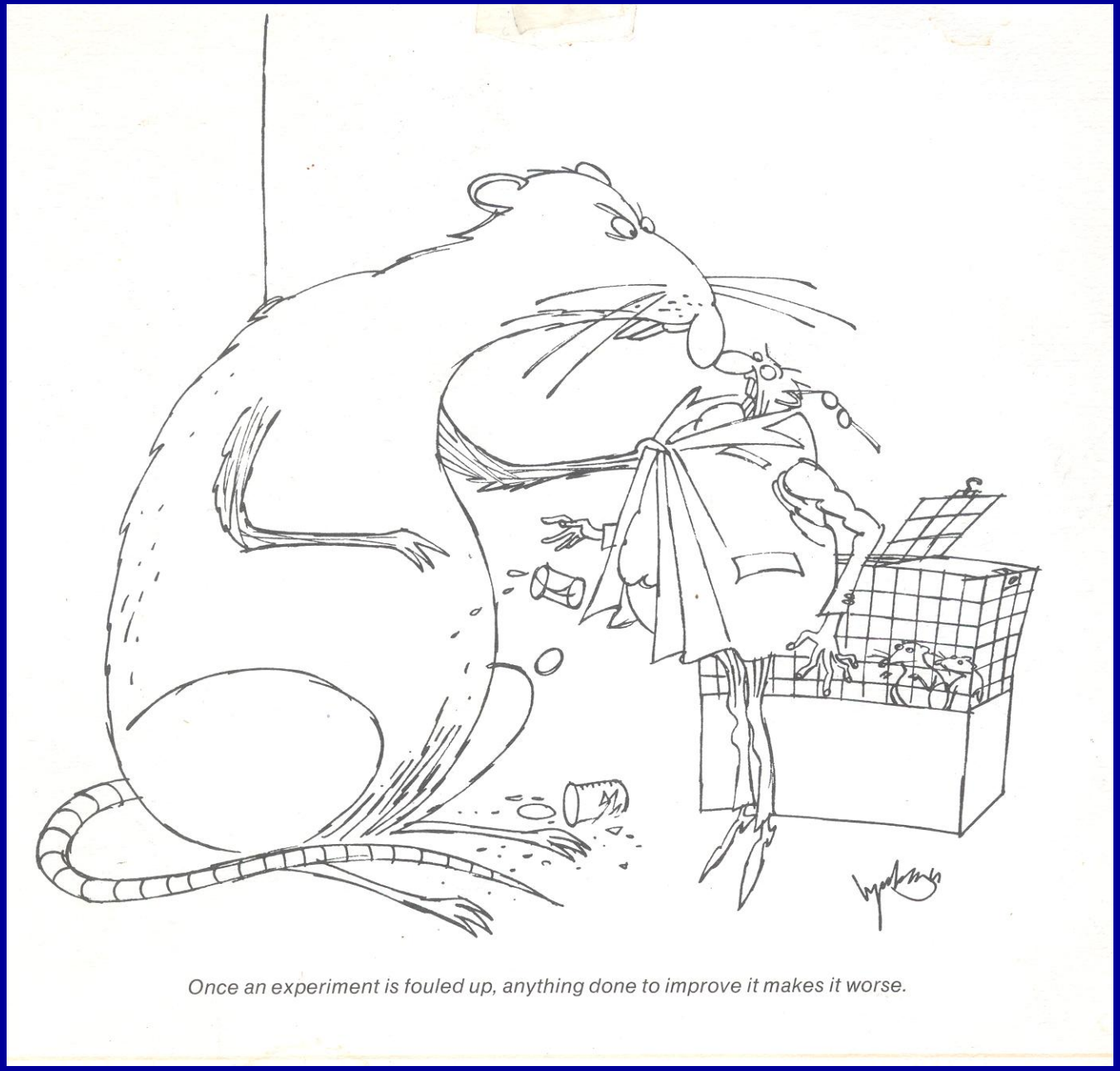
- Do not EVER give results to more than 3 figures since no one can pipet this well!
- Do not routinely "normalize" or take out "errant" points

Establish Conventions

- Put standards on same side of gel
- Put control before experimental
- Use the same color for control and a different color for experimental when labeling tubes
- Try to make data analysis as easy as possible (for example, by using the same percentage of medium and lysate)

Experimental Analysis, II

- Do not keep repeating an experiment again and again in the hopes of getting a different answer.
  - You must change something! (get advice)
- Do not be afraid to change your entire approaches/project if you have really tried your best and you have not been able to get an unambiguous answer



Once an experiment is fouled up, anything done to improve it makes it worse.

You Need to Know How it Works

- Make sure you understand the theoretical basis for all:
  - Kits you are using
  - Equipment you are using
  - Techniques you are using
- You can't troubleshoot if you don't know what is happening
- Company literature and Internet can help

How to Develop Analytical Skills

- Critique your experiments before you ask for advice:
  - locate possible sources of artifact and error
  - compare your results to published data in terms of units
- Read, read, read the literature in your area!
- Thinking *vs* Doing: remember to balance

Reading the Literature

- You are responsible for finding and digesting all papers relevant to your projects
  - Your mentor will love it if you provide them with hot new references related to lab projects
- Learn to read papers critically. Were enough controls done? What is really new in the paper? What would be the next step?
  - Not all papers in Cell or Nature are true…

How to Organize a Project

- Plan a paper! (aim for top journal)
- Make a flow diagram of what you would like to put into this paper (things will change)
- Set up a timeline for accomplishing the various parts of the project (specifics)
- Line up all reagents and people you need well in advance

When You Have Problems

- First analyze the experiment yourself, then take this analysis and get help
- You must show you have mastered the technique before you can claim that the line of work is unprofitable- reproducible results?
- Investigate the use of alternative techniques
  - Depending on the importance of the problem, you may want to use several approaches simultaneously

Other Problems in Grad School

- Mentor not available to you
  - Pros and cons- you *will* become independent; however, time will be lost
  - Most mentors will meet at least once or twice a week with students
- Courses *vs* lab work- reach a balance
- Troublesome interpersonal dynamics in the lab
  - Go to your mentor and discuss privately

What to do if you have fallen out of love with your project

- Think about why the experiments no longer interest you
  - Personal reasons?
  - Constant ambiguity in results? Hypothesis wrong?
  - Too small a question?
  - No existing context for the question?
- Decide with your mentor if it is time to switch projects; if not:
  - Read more papers in the general area
  - Go to a meeting and present your results to the group of people who work in this particular area

Ideas

- "The best way to have a really good idea is to have lots of ideas"- *Linus Pauling*
- Ask if you can branch out to explore potentially interesting side areas which always pop up
  - Do not be afraid to pursue the most important problems
  - Do not continue indefinitely if unproductive, time-consuming and/or costly (risk-benefit analyses!)
- Focus on questions, not on techniques
- You will get better at generating ideas over time!

Obtaining, Organizing, and Presenting Information

Obtaining and Organizing Information

- Technique manuals = "Red Book"
- Online manuals and lab websites
  - Google as technical aid
- Lab protocols
- PubMed – look for papers
- Company technical information and equipment manuals
- People: seminars, emails and phone calls

Obtaining and Organizing Information

- Never let your experimental data pile up without filing. YOU WILL FORGET!
- Summarize your conclusions on the first page of your experiment when filing; paperclip expts
  - Go look at previous lab members' notebooks. Which ones are helpful?
- Keep a separate protocol notebook
- File your references by subject and/or author
  - Consider the use of color
- Organize your computer files- papers, techniques, letters, coursework. Back up!!

Obtaining and Organizing Information

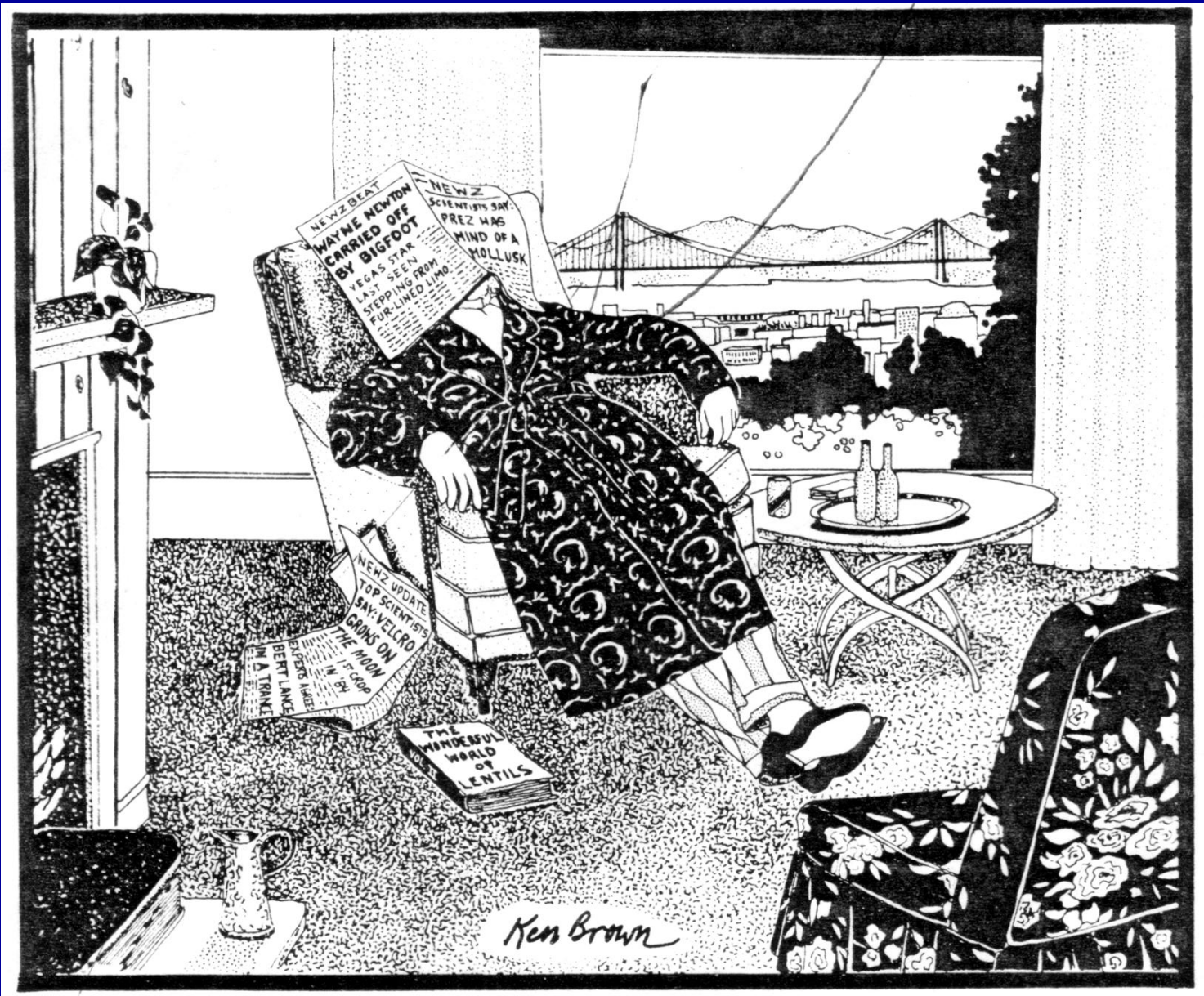
- Databases- immediately learn how to access CRISP, PubMed, any others pertinent to your research
- Programs- learn very early how to use a scientific graphing program and any other specialized programs your lab uses

People Resources

- Your mentor
- Other faculty members are always willing to help
- Colleagues - students, postdocs, technicians
- Seminar speakers
- High school and college friends!
- (eventually- anyone you have ever met, at meetings and other scientific venues!)

Giving talks and writing papers and grants

- See website!
- The more often you practice, the better you get



NEUROTRANSMITTERS TAKE A HOLIDAY

Maximizing Your Grad School Experience

Choosing A Thesis Advisor

- Interesting work (to you)
- History of productivity
  - Search Pubmed
- Funded
  - Search CRISP (NIH only; but many other sources exist)
- History of graduating students within 5 years
  - Check history!
- Personnel from the lab have done well in the past (ask them; look them up)
- Good personal interactions- compatible styles

Funding Your Graduate Work

- F32 awards for US citizens
- Disease foundations for non-citizens
  - Ineligible if you apply too early or too late during graduate school

Mentors are Impressed by Grad Students Who…

- Set their own deadlines (projects, papers, grant applications, exams) and actually meet them
- Read the literature on their own
- Think critically about their own experiments and those of others
- And of course, work hard…

Consider Taking on Multiple Projects

- Discuss with mentor if you are ready to take on side projects
- Offer collaborations with other lab members, if mentor approves
- Outside collaborations provide other letters of reference

Attending Seminars

- Stay awake, listen, look
- Try to anticipate where speaker is going
- Weigh the data- are conclusions supported?
- Mentally critique the speaker- could he/she have given a better talk?
- Think of questions to ask
- Take notes

Seminar Speakers

- Use your time with seminar speakers wisely
  - Ask about merits of various techniques
  - Ask for feedback about your research
  - Ask about postdoctoral opportunities or grant opportunities
- Driving seminar speakers to and from the airport provides valuable one-on-one time

Attending a National Meeting

- Meet as many people as possible
- Learn about as many new techniques as possible (relevant to your work)
- Acquire reagents and collaborators
- Look at style of presentations as well as raw data and conclusions- what field/technique/question impresses you most?
- Try to get something out of every talk you attend and poster you visit

Funding Meeting Travel

- Many meetings offer travel support for students who are presenting as first authors
  - WCBR; Endocrine Society; ASCB; SfN
    - See websites and plan ahead
  - Looks very good on your resume

Try to Accumulate Honors
this will distinguish you from others

- Poster awards
- Travel awards
- Training awards
- Fellowships

For Non-native English Speakers

- Try to take speaking and writing courses
- If this is not possible, get a native speaker to correct a half page of your writing several times a week
- There are no jobs for Ph.D.s who cannot formulate reasonable sentences in English

Meeting Your Deadlines

- Personal *vs* official deadlines
  - You should have both!
- Procrastination
  - "The best enemy of achievement"
  - "The difference between your priorities and your results" (Barker, "At the Helm")
- Perfectionism
  - Sometimes valuable (quality products), but not if it keeps you from finishing a task

Program Expectations

- Finish qualifying exam by the end of the second year
- Finish proposal in the next semester
  - Varies by program
- Organize your committee meetings WAY ahead of time as faculty schedules will fill up

Qualifying Exam

- Tests your basic knowledge of a discipline
- Tests your knowledge of your specific field
- Do not be afraid to contact faculty for help during proposal preparation!
  - Committee- literature, technique tips
  - Mentor- general suggestions for improvement
- Ask fellow students for examples

Learn To Multi-Task

- It is neither necessary nor desirable to take 2-3 months off from the lab to prepare for your qualifying exam!
- You can devote some time each day to benchwork and some to literature analysis

Call On Your Committee!

- To help with experimental design and supply references for techniques
- To outline a game plan and keep you on track
- If your advisor won't let you leave
- A yearly meeting is required! More frequent meetings are better.

Taking Initiative and Assuming Personal Responsibility

- You must seek out help when you need it
- Be proactive in other areas too- in suggesting seminar speakers, in locating new papers relevant to your research,
- You must become an expert in your field!

Taking Initiative and Assuming Personal Responsibility

- Your mentor may identify meetings for you, but you can also identify meetings in the field -and scholarships!
- Pre- and postdoctoral fellowships all have deadlines; you have to identify and meet them!
- Do not leave any lab without finishing your manuscripts

Working With Others

- Documented ability to work in teams is critical for industry/biotech jobs
- Must prove that you can direct students
  - Don't turn down summer undergraduates!
- Being a good lab member means helping out with chores without being asked
- Synergy: you get more done when each person helps a project with their particular expertise! Volunteer to help.

Learning How to Mentor Others

- Undergraduates are valuable sources of labor but must be taught basic research as well as background
  - Positive: help with laborious techniques
  - Negative: need to train, often many times, as well as closely supervise= time-consuming
- Supervision includes making sure students keep a good lab notebook

Other Grad School Opportunities

- Voluntary teaching- helps presentation skills
- Collaborations- you can initiate under certain circumstances (ask your boss)
  - Provides more faculty recommendations
- Reviewing papers (ask your mentor if possible)
- Learning as much as possible at all times-
  - Techniques which may be useful in the future
  - Operating specialized equipment
  - Mini-courses from companies
  - Seminars from all departments (2-3 a week maximum)

Starting Collaborations and Getting Reagents

- Your mentor will generally be the one who writes another lab for reagents and collaborations
- However, you can make suggestions for collaborations and reagents that will facilitate/expand your work

Writing Reviews

- Volunteer to help write reviews that are requested of your mentor
- If there is no recent review of your field, ask your mentor if you can write one
- You will need to show that you can multi-task effectively (ie keep up with benchwork) before your mentor will agree

Looking for Postdoctoral Positions

- It is never too early to start identifying potential postdoctoral mentors and grant opportunities
  - Invite for seminars; look up at meetings
- Look for a mentor whose previous postdocs have been successful (ask where they have gone; talk to other lab members)
  - Funding
  - Publications

What Do PIs Look For in Postdocs?

- INDEPENDENT thinkers!
  - Ability to trouble-shoot, analyze results critically, and think of the next step
  - Ability to set up new techniques from the literature
- Hard workers with a passion for science
- Appropriate background for the lab
  - Best: bring something new to the lab
- Willingness to write a grant to support themselves
  - Must plan at least a year ahead in order to do this

Writing a Postdoctoral Training Grant (F32)

- You need to show you will grow intellectually
  - Going to another institution recommended
  - Learn other techniques or a new field
- Identify an experienced postdoctoral mentor
  - One year or more before anticipated graduation
  - Be proactive- most people are looking for fellows
  - Submit your proposal well before moving
- Success elements - in order of priority
  - Your mentor's reputation (pubs, grants, status)
  - Your own accomplishments (grades, pubs)
  - Training plan (courses, techniques to be learned)
  - Research plan (clear, doable)

Graduate Student Bill of Rights

- You will receive general training in a specific field
- You will receive training in experimental design
  - You will meet regularly and often with PI and other trainers
- You will receive training in writing papers and grants
  - You will write the first draft of papers
  - You will get input on your proposals and see your mentor's
- You will receive training in giving talks
  - Your mentor will listen to you first before you go public

- If your mentor is not training you in these areas, ask why!

At the End of the Day…

- You are not an "electrophysiologist"- you are trained in SCIENCE
- You have valuable design and analytical skills
- You can organize information efficiently
- You have communication skills, written and verbal

- You are trained for many jobs!

Do Not Worry About Your Ability to Do Things in the Distant Future

when the time comes, you will have those skills!

Resources

- At the Bench, by Kathy Barker (Cold Spring Harbor Press)
- At the Helm (same author)
- Survival Skills for Grad Students: talks, posters, grants, papers, jobs: http://www.med.uwo.ca/physiology/courses/survivalwebv3/frame.htm
- Similar Site Run by IBRO: http://www.ibroedu.org
- MIT's site: http://web.mit.edu/career/www/workshops/CV/RelatedLinks.html
- Grant writing: http://cpmcnet.columbia.edu/research/writing.htm
- Tips on Writing Scientific Reports: http://www.wisc.edu/writing/Handbook/ScienceReport.html
- American Society for Cell Biology has lots of information:
  - http://www.ascb.org/careers/

Resources- Predoctoral and Postdoctoral Fellowships

- grantsnet@aaas.org
- NIH individual grant
- NIH training grant
- Many, many other sources- disease-related
  - AHA and ACS are the largest
- NIH research training opportunities http://grants.nih.gov/training/nrsa.htm
- Howard Hughes Medical Institute http://www.hhmi.org
- Alfred P. Sloan Foundation http://www.sloan.org
- Burroughs Wellcome Fund http://www.bwfund.org
- Robert Wood Johnson Foundation http://www.rwjf.org
- Many, many disease foundations

The future….