HOW TO GET STARTED IN RESEARCH WITH UNDERGRADUATES

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Outline

- I. UNDERGRADUATE RESEARCH BENEFITS
- II. WHAT RESEARCH YOU SHOULD WORK ON
- III. GRANTSMANSHIP
- IV. PROPOSAL WRITING
- V. REVIEWERS
- VI. ADMINISTRATION & RESEARCH CULTURE RELATED TO YOUR NEEDS
- VII. STUDENTS AND THEIR SELECTION
- VIII. GROUP STRUCTURE
- IX. MENTORING UNDERGRADUATES
- X. COLLABORATIONS – BENEFITS & PITFALLS

Undergraduate Research Benefits

- Research complements and enhances traditional instructional activities and exceeds them. Specific benefits include:

  - ✓ working on an extended problem
  - ✓ facing realistic problems leading to original discoveries
  - ✓ independent thinking and improved problem solving skills
  - ✓ one-on-one contact with a skilled mentor
  - ✓ students see the magnitude of the scientific enterprise
  - ✓ developing speaking & writing skills
  - ✓ possibly interactions with other scientists
  - ✓ demonstrates how new knowledge is gained
  - ✓ learning to accept ambiguity & failure on the journey to discovery

WHAT RESEARCH YOU SHOULD WORK ON

- Work on research with which you are familiar and can start quickly
- Your research should be distinctive from and uncompetitive with what you did in graduate school or as a post-doc
- Try to get input from your mentors on the soundness of your ideas
- Get the permission of your mentors if your research is close to theirs

WHAT RESEARCH YOU SHOULD WORK ON

- Ideally your research should relate to your educational goals
- Doable with local resources and expertise
- Make optimal use of undergraduates to increase its visibility on campus
- Divide into projects appropriate for the academic year and summer
- Develop more than one major project.

GRANTSMANSHIP

- Generate meritorious, original research idea
- Bounce it off your mentor (department, CUR)
- Find funding sources – Grants Office, CUR, Google…
- Contact program officer – have ideas written out for phone conversation
- Prepare and submit grant proposal as early as possible
- You may contact program officer during review

PROPOSAL WRITING

- Follow the guidelines carefully.
- Use the language of the guidelines – aims for aims, hypotheses for hypotheses, etc.
- Words are important. You are not writing a manuscript for publication. So use qualitative terms when they benefit you. e.g. if a proposed synthesis has a 2% yield, say something like “Although the yield has been reported to be low, it is the only way to produce the chemical intermediate.”

- Conversely, if a process becomes more favorable the faster it occurs, then say “The process is four orders of magnitude faster when”… rather than “The process is faster when”…
- If your proposal includes disparate parts, describe what unifies them so that reviewers won’t criticize your proposal for sounding like a shopping list

- Avoid “lynchpin” experiment in a proposal.
- Long-range plans. Proposal is mostly about work to be done during first funding period. But you must present the complete idea, including future directions.
- Have a mentor (colleague) read your proposal and make candid comments. Incorporate their suggestions.
- Submit to more than one agency or submit 2nd proposal immediately after considering reviewers’ comments from 1st submission.
- Don’t be thin-skinned about reviewers’ comments.

REVIEWERS

- Some of them will not be the people you suggested. So write your proposal with sufficient background to allow even a non-expert to understand your ideas.
- Some of the reviewers of your first submission will be used by the agency to review your additional submissions. Make their suggested changes.

ADMINISTRATION, RESEARCH CULTURE, YOUR RESEARCH NEEDS

- Administrators are there to help – commun-icate with them and bring them on board
- Start-up support – Increase $$$ amount by expanding first year to 366 days
- Department resources
  - ✓ Lab space – 600 square feet
  - ✓ If space is limited, build vertically
  - ✓ Use department instruments if necessary
  - ✓ Institutional support for your summer research
  - ✓ Grants office and adequate library

ADMINISTRATION, RESEARCH CULTURE, YOUR RESEARCH NEEDS

- Department culture
  - ✓ Clearly stated departmental expectations
  - ✓ Department mentor and/or external mentor (CUR)

- Time
  - ✓ <12 contact hours per week
  - ✓ No summer teaching
  - ✓ Support staff: lab manager, instrumentation technician, post-doctoral fellow

- Time
  - ✓ Teaching schedule with minimal supervised labs and lecture preparations; include large blocks of time
  - ✓ Organize lab with labeled desks
  - ✓ Written protocols for routine procedures
  - ✓ Limited committee work during first two years

- Strategies for success and change
  - Be a problem solver, not problem maker
  - Show how your research is compatible with institutional strategic plan – teaching and research are equal
  - Volunteer to maintain a departmental instrument, organize research poster session, write departmental grant proposal…
  - Make clear the benefits of undergraduate research
    - ✓ external funding and indirect cost money
    - ✓ national recognition
    - ✓ student recruiting

STUDENTS AND THEIR SELECTION

- They need not have the highest GPA
- They should be curious, inquisitive, dedicated and diligent
- Be able to work independently and in collaboration with others
- They need to be able to work carefully
- Ask your colleagues for student recommendations

GROUP STRUCTURE

- Students with a range of experience
- Maintain continuity with students who will work in your group during more than 1 year
- Appropriate groups size is necessary for
  - ✓Student satisfaction and understanding
  - ✓Leadership development
  - ✓Research productivity
  - ✓Giving you more personal time

MENTORING UNDERGRADUATES

- They require considerable individualized attention
- Be friendly with students but find what level of familiarity with them is appropriate for you
- Even the brightest student can accomplish only so much
- Give them adequate background and reading
- Set ground rules that you intend to enforce
- Trust is more easily lost than gained
- Their goals are not the same as yours

- Be patient. Don’t sweat the small stuff
- You are now a role model
- Think before you speak in front of them
- Emphasize laboratory safety
- Learn how to motivate students who have little initiative
- Discipline them to maintain good records
- Give encouragement on failed projects
- Above all, be accessible

COLLABORATION - BENEFITS

- Makes available additional methodologies, equipment, and expertise
- Possible greater productivity per dollar
- Cross-fertilization of ideas may enhance chances for funding
- Allows you to stay abreast of a greater range of research
- Can serve to bring together a range of departments
- May lead to new innovative curricular ideas
- Develop student skills needed in future employment
  - ✓Teamwork
  - ✓Multi-disciplinary cooperation
  - ✓Develop skills for communication across boundaries of traditional disciplines

COLLABORATION - PITFALLS

- Structures of departments and divisions dictates budget and indirect cost allocations
- Research timescales may be different
- Faculty evaluation - Who receives credit can be important in promotion and tenure decisions.
- Must demonstrate to reviewers and research community that the level of research and intellectual rigor match that of single disciplines

NEW FACULTY

- Assess the culture of your department and institution
- Clearly delineate what aspects of the research will be worked on by each partner
- Seek advice from people with experience. Contact organizations such as CUR
- Establish a contractual agreement with industry
- Collaboration is less risky after tenure