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Purpose: This course is designed to introduce beginning graduate students to the fundamental methods of research and scholarship necessary for a successful career as a graduate student, teacher, and independent research scientist.

The course will address a number of issues faced by all graduate students including the selection of a research advisor, proper expectations in the student/advisor relationship, how to be an effective research scientist and teacher, and preparation for qualifying examinations.

Topics related to developing a familiarity with essential “tools” of the research scholar, including the use of archival literature and less formal sources of information, will be developed in detail. A special emphasis in the course will be placed on developing skills for effective scientific writing (of research reports, original research proposals, and scholarly papers) and oral presentation (of teaching lectures, poster presentations, and research seminars).

The course will also address a variety of *ethical issues* including proper academic conduct, objectivity and ethical behavior in research, plagiarism, and the rules of proper citation in writing and oral presentation.

Audience: The class of first year graduate students in the chemistry doctoral program. The course may also be offered to advanced undergraduate or masters program students. The aim is to create an informal atmosphere where all students are encouraged and expected to participate in discussions.

Format: This course will be offered in the fall semester for 2 credits and consist of weekly, two-hour meetings.

The designated faculty and student co-coordinators will oversee the course. Faculty and student co-facilitators will typically lead weekly meetings of the course. Lecturing will be kept to a minimum. Students will explore topics through guided discussions, analysis of “case studies,” assigned readings, and written assignments.

Grading: The course will be graded. To pass the course it will be necessary to participate actively in group discussions and complete all course assignments.

Text: Graduate Research: A Guide for Students in the Sciences, Robert V. Smith, University of Washington Press (1998); On Being A Scientist: Responsible Conduct In Research, National Academy of Sciences (1995).

Suggested Reading: Advice to a Young Scientist, P.B. Medawar, Basic Books (1979); An Introduction to Scientific Research, E. Bright Wilson, Jr., Dover (1990). The Visual Display of Quantitative Information, E. R. Tufte, Graphics Press (2001). 100 Writing Remedies: Practical Exercises for Technical Writing, E.H. Weiss, Oryx Press(2001).

Week-by-Week Course Outline: Topics for Discussion

9/9/03 **Week 1: Perspectives on graduate study:** An opportunity for students to share views on graduate study. “How I got here” testimonials will be delivered from a panel of graduate students, postdocs, and faculty members. Panel members will then separately lead small groups of students in discussion.

<p>Student instructors: Peng/Celenligil Postdoctoral instructor: Bradley Faculty/Staff instructors: Elliott/Porco/Mullin</p>

9/16/03 **Week 2: Selecting a Research Advisor (graduate students only):** A discussion of what students should look for in a Research Advisor and group.

The student-led discussion will cover Research Saturdays, rotations, and a review of questions students should have answered before selecting a Research Advisor: funding expectations, teaching requirements and expectations, lab atmosphere, time requirements, time working each week, time to graduation, vacation leave, and support for travel to meetings. An emphasis will be placed on students recognizing their own goals and interest, and in finding the best match in a Research Advisor.

<p>Student instructors: Eastwood/Hertzler/Peng/Troast/Hu</p>

9/23/03 **Week 3: Reading the scientific literature (I):** An overview of the various forms of “published” research literature. Survey of tools for collecting and managing references.

Library and on-line journals, call numbers of commonly used journals by field, and less formal forms of “published” research including preprint databases, oral and poster presentations, and private communications will be discussed. How does one judge the quality of published research? How does one become a critical reader of the literature? How does one come to appreciate the status in ones principal and related fields of research?

Ethical questions: What knowledge is yours and what must be attributed to others?

<p>Student instructors: Datta/Hu Faculty instructors: Mohr/Schaus</p>

9/30/03

Week 4: Reading the scientific literature (II): An emphasis will be placed on applications of “tools” developed in the previous week. Case studies will explore how topical areas can be researched, and how papers can be read critically. Students will be assigned topics to research and papers to read in preparation of the class meeting.

Student instructors: Hertzler/Peng

Faculty instructors: Mohr/Schaus

10/7/03

Week 5: Choosing a research problem: What is the question? Has it been addressed in the past? Why does it matter? What do you hope to accomplish? Is the scope of the proposed project realistic? The scientific method: What is hypothesis driven research? Is there any other kind?

Progress in graduate research: What is to be expected and acceptable, and how to recognize it.

Ethical questions: What is acceptable behavior in independent research and competition in science? What constitutes fair competition with a respect for the “ownership” of ideas?

Student instructors: Hongbin/Mankoo

Faculty instructors: Porco/Georgiadis

10/21/03

Week 6: Experimental design, and collecting and managing data (I) –The basics: The importance of order of magnitude estimates and stepwise controls. Careful experimental design can improve the effectiveness of a research plan. However, what can be known and planned for in the course of any novel study of a complex system is limited. How does one know where to draw the line? Using results to validate conclusions of a study.

A discussion of examples of how to manage a “lab notebook” and data sets, including case studies of what can go wrong when data is not properly recorded, managed, or stored. What special considerations should be made when the research results may be used to support patent or copyright applications? The discussion will include a review of Boston University guidelines for collecting and managing data.

Ethical questions: Drawing and presenting conclusions: When is it acceptable to discard data?

Student instructors: Hertzler/Landsmap

Faculty instructors: Georgiadis/Schaus

10/28/03

Week 7: Experimental design, and collecting and managing data (II) – Analysis and presentation: A discussion of how to recognize statistically significant trends in data and the importance of error analysis. A discussion of case studies will demonstrate the importance of critical reasoning in data analysis. A presentation and discussion will explore effective methods for visually presenting data.

Ethical questions: How does one draw the line between “making a point” and “pulling the wool over the reader’s eyes” in the presentation of data?

Postdoc instructors: van Giessen/Beeler Faculty instructors: Caradonna/Georgiadis
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11/4/03

Week 8: Writing I - Effective writing: A brief review of fundamental rules of grammar and clear writing. Topics for discussion will include the use of active voice, the use of short sentences, eliminating redundancy and jargon, editing, and proofreading. Case studies will present a variety of commonly made errors and misused words. Students will also be introduced to the services provided by the Boston University’s [Education Resource Center](#).

Staff instructors: Csigi/Piniero Faculty instructor: Elliott/Schaus
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11/11/03

Week 9: Writing II - Developing research papers: The roles of the title, abstract, introduction, materials and methods, results, figures, tables, legends, discussion and conclusions will be reviewed. A discussion of where to start and how to proceed in writing a research paper will conclude with an analysis of well-written and flawed papers.

The importance of peer review, by students, postdoctoral fellows, and faculty, in developing drafts of research papers will be emphasized.

Ethical questions: How and when does one cite primary and secondary sources? What constitutes plagiarism in course work and in published research?

Student instructors: Foster/Bu Faculty instructors: Elliott/Schaus

11/18/03

Week 10: Writing III - Preparing research proposals: A discussion of commonly made mistakes and case studies of successful proposals. The purposes of the background and significance, preliminary results, design of the research plan, and development of a budget will be reviewed.

The program will include graduate student testimonials and example written oral qualifying exam proposals. Examples of research grant proposals will be provided and discussed.

Ethical questions: What constitutes an “original” research proposal?

<p>Student instructors: Foster/Bardhan Faculty instructors: Caradonna/Straub</p>
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11/25/03

Week 11: Oral presentations I - The basics: Preparing material, effective visuals, common mistakes (“reading” the presentation, overestimating the knowledge of the audience, the use of jargon, legibility of visuals), engaging the audience, practicing and critical evaluation, preparing for questions, and how to answer questions effectively.

There will be a discussion of effective methods for brief presentations of select ideas, in the context of short presentations to students in a teaching laboratory, a discussion section, or during a poster presentation. Example presentations will be made to demonstrate best and worst practice in oral presentations.

Ethical questions: What constitutes proper scholarship and citation in oral presentations?

<p>Student instructors: Bardhan/McDougal Faculty instructors: Smith/Elliott</p>

12/2/03

Week 12: Oral presentations II – The great debate: A “pub debate” will take place around a predetermined topic. Students will be given one week to prepare brief presentations of positions – both pro and con. The debate will consist of students making individual five-minute presentations. Each presentation will be followed by 2 minutes of questions and challenges. The presenting student will then be given two minutes for rebuttal. A panel of students, postdocs, and faculty will judge the debate.

<p>Student “judges”: Wolf/McDougal Postdoc “judge”: Moore Faculty “judges”: Smith/Elliott</p>
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12/9/03

Week 13: Mentoring relationships and ethics: The discussion will include mentoring expectations, the role of the Dissertation Advisory Committee, financial support, research direction, and support beyond graduation. Where do graduates of labs go after graduation?

Ethical questions: What constitutes civil and acceptable behavior in the academic environment? What constitutes reasonable behavior and proper respect in graduate student/advisor, graduate student/graduate student, and teaching fellow/undergraduate student relationships? What are the limits of confidentiality and respect for privacy?

<p>Student instructor: Woo/Datta Postdoc instructor: van Giessen Faculty instructors: Mullin/Straub</p>
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12/12/03

Week 14: Life after Graduate School: An open “panel” discussion will explore postdoctoral opportunities, including government and private foundation fellowships, in research and teaching, and job opportunities in industry, government laboratories, education, and academia. Attendance at the NSYCC career symposium will be promoted as a means to gain broad exposure to career opportunities in chemistry.

The panel discussion will be followed by a reception and end-of-the-semester celebration open to all students, staff, and faculty that participated in the course.

Ethical questions: When a student leaves a research group, what ideas can she take with her as her own?

<p>Panel members: TBA Student instructor: Wolf Faculty instructor: Straub</p>
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