

**UNIVERSITY OF KANSAS – SCHOOL OF PHARMACY  
DEPARTMENT OF PHARMACOLOGY AND TOXICOLOGY  
GRADUATE PROGRAM HANDBOOK**

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## INTRODUCTION

Welcome to the graduate program of the Department of Pharmacology and Toxicology. The department has prepared the following statement regarding our overall philosophy of graduate training in order to help you understand our goals for you. This is followed by some detailed information about all kinds of things that we hope will make your adjustment to graduate school very easy and pleasant.

This is an exciting time to be starting your graduate training in pharmacology and toxicology. Training in these two disciplines will allow you to acquire knowledge that is broadly based on major chemical and biological fields such as biochemistry, medicinal chemistry, molecular biology, cell biology, and behavioral biology. The revolutionary advances in the last few years in the biomedical sciences have had a tremendous impact on the disciplines of pharmacology and toxicology. These two disciplines are hybrid disciplines; i.e., knowledge of and experimental approaches from all fields of the biological and chemical sciences are used to probe mechanisms of action of therapeutic or toxic agents. Advances in the molecular sciences, including genomes, over the past two decades have opened up great opportunities for understanding the mechanisms of action of chemical agents on biological systems and for designing new drugs that can affect specific cellular processes and the function of specific macromolecules.

Our faculty is committed to providing you with the best training and research opportunities possible. We are also committed to the concept that we are involved in the training of junior colleagues. This concept is very important for you and the faculty. For you it means the following:

1. During your first semester as a Ph.D. student you will participate in three laboratory rotations. The directors of these laboratories are the potential mentors for your dissertation research. M.S. students will speak with potential mentors upon entry into the program and, together with the faculty member, choose a mentor. Upon entry into the laboratory, you will be asked to become involved in the research activities of the laboratory, contribute to the research productivity of the laboratory, and contribute to the training of less experienced students. From the beginning of your career in science you will be interacting closely with a mentor.
2. You are participating in a program that was designed to maximize your training in functionally important aspects of the profession (such as writing scientific papers and research proposals) and to avoid requirements that represent non-functional experiences.
3. You are included in the "life" of the department as a full participant, e.g. in scientific discussions, in faculty meetings (through a representative), and in the decision-making processes.

Your designation as a junior colleague bears, of course, certain important responsibilities which must be incorporated in your everyday life while you are a member of our department. The most important among these are the following:

1. Dedication to the science of the discipline. You are here to maximize your learning and acquire the skills to conduct independent research in some of the most modern and important fields of scientific research. You now need to function as an independent thinker and dedicated scholar. This is a lifetime commitment to scholarship which goes far beyond attending class lectures and doing well in examinations.
2. Conducting yourself as a good “citizen” of the department. You will be called upon to assist other students in their training, assist faculty (senior colleagues) in conducting their research and teaching missions, and assist the department in the maintenance of all research and instructional facilities.
3. Exhibiting the highest standards of ethical behavior. Each one of your actions in the classroom or in the laboratory must be governed by an absolute adherence to honesty and consideration of the rights of other faculty, students, staff, or other scientists in general. To be a scientific colleague to all these people, you must be unquestionably trustworthy. Ethical behavior, not simply intelligence, is at the core of a long-lasting career in science.

In the pages that follow, you will find much useful information about how to structure your life in graduate school and how to plan your training and research activities. We encourage you to take responsibility for structuring your own program in consultation with your mentor and the department’s graduate program director.

## **ON BEING A GRADUATE STUDENT**

Graduate training is designed to help you become a professional, practicing scientist. Thus, there are many expectations placed on you which differ from expectations we have of undergraduate students. These higher expectations might be a little overwhelming at first, especially for students adjusting to a new culture and language. Students may contact CAPS at 785-864-2277 or visit Watkins Hall Room 2100 for counseling or referral for other services. The following paragraphs highlight these expectations. We hope you will use these guidelines to help plan your time and set your priorities while you are a graduate student.

### Time in the laboratory

You should realize that your laboratory work contributes to the development of two careers: your own and that of your mentor. Furthermore, the more work that gets done, the more quickly you can finish your degree and move to the next level. Minimally then, you should plan to work **a minimum of 7 to 8 hours per weekday in the laboratory and work on least one weekend day for a few hours**. Optimally, you may wish to

work significantly harder. During your first year, class time may reduce your lab hours somewhat, but full time in the lab is expected once your course work is completed.

### Time to study for courses

The Graduate Studies Office requires a grade of “B” or better for all required graduate course work and an average GPA of at least 3.0. This usually means that you must devote a significant amount of time and effort to studying for your classes, especially during your first two years. However, we expect that you will accomplish this by **studying at night and on weekends rather than during the weekday hours when you should be in the laboratory.**

### Reading the literature

It is impossible to perform good science without a thorough knowledge of the current literature. Over the course of your graduate career, you are expected to become familiar with the literature in your area and, gradually, to extend the scope of your reading to other areas. Other areas include those topics that happen to be current in the general literature, particularly in journals such as Science or Nature.

In pursuit of this literature familiarity, you should become familiar with the **names** and **accomplishments** of individuals working in your field on interest. You should also become familiar with the names and accomplishments of other prominent scientists. Reading literature somewhat outside your own area as time permits may help you in choosing a postdoctoral position and will certainly contribute to your education.

A reasonable strategy for achieving these goals is to read or skim heavily one article per day from the current literature. This is probably only practical if you have passed your exams or if it is the summer. Therefore, when you take a full course load, you should try to read three papers per week during the fall and spring semesters.

### Internships

Ph.D. students may take time off from their work in their mentors' labs to accept an internship. The internship must take place after the student passes the comprehensive exam. Students will not receive a stipend from the University while they are engaged in an internship but they may accept one from the company for which they are interning. Students are advised, however, that accepting an internship may mean that they will be required to delay their graduation for a period of time (determined by their mentor) in order to make up for the lost time working on their dissertation project.

M.S. students may accept an internship during the summer before their second year, but are advised as well that this will delay their graduation for a period of time (determined by their mentor) in order to make up for the lost time working on their thesis project.

Students are advised to consult with faculty members prior to selecting a mentor and joining a lab if they are considering applying for an internship at any point during their

graduate programs. Because the nature and duration of the research taking place in each lab varies, mentors, at their discretion, may or may not allow students in their labs to accept internships.

## **THE DOCTOR OF PHILOSOPHY DEGREE PROGRAM**

The course of study leading to the Ph.D. degree usually requires five years to complete. You are expected to devote the full 12-month year to your pursuit of graduate studies, with some time off for holidays and vacation. You will begin lab research training as soon as you enter the program, though a significant amount of time in the first two years will be devoted to learning basic concepts through formal coursework.

You are required to take a core of basic courses in pharmacology / toxicology, biochemistry, and molecular biology. If you have successfully completed an equivalent course at another university, it need not be repeated. In addition to the core requirements, in consultation with your mentor, you may choose courses based on your own research interests or courses designed to provide specific research skills as discussed below.

One component of our training program from which you will benefit greatly is the opportunity to learn the art of presenting lectures in undergraduate classes and formal seminars describing your research projects. Careful mentoring and opportunities to practice using very practical presentation strategies lead to the development of excellent communication skills and self-confidence in our graduates.

Some of the most important parts of graduate training involve learning how to ask good research questions, how to design and carry out experiments to answer those questions, and how to write up the results of the experimental work in a clear and concise manner. For this reason, you will begin your lab rotations as soon as you arrive. After you choose your mentor, you will begin a research project. As your research continues, you will develop a dissertation project with your advisor's assistance. Once your coursework and exams are completed, you will devote all of your time to your research projects and the preparation of papers describing your work.

### **A. Ph.D. Course Requirements**

As a new graduate student, you should have completed 4 semesters of chemistry and 4 semesters of biology, including a course in cell biology and one in biochemistry. Prerequisites may be completed during your first year. The core courses in pharmacology and toxicology that are required of all students are listed below. The prerequisite for all courses is graduate standing in the Pharmacology and Toxicology Graduate Program.

Students are required to maintain a cumulative GPA of a "B" or better. (Students are allowed to receive a grade of "C" in a maximum of 2 courses while they are enrolled in the program. After those 2 courses, students receiving a "C" will need to retake the course at their own expense).

**P&TX 700: Professional Issues in the Biomedical Sciences (Muma)-2 credits**

This course is designed to assist doctoral students in the biomedical sciences in their professional development by providing presentations, discussions, and practical experiences related to career development. Topics include preparation of vitae/resumes and other elements of a successful job search, writing scientific papers and dealing with editors, preparing an NIH grant application for students' oral comprehensive exams, and balancing professional and personal obligations.

**P&TX 730 (I): Advanced Pharmacology I- CNS and ANS (Zhao)-3 credits**

A detailed study of the fundamentals of autonomic nervous system, central nervous system, and their pharmacology. The students will attend select P&TX 630 and 631 lectures and meet separately with the faculty for additional discussions of advanced material on the topics. The students will be examined on the advanced material.

**Prerequisite:** Graduate standing in Pharmacology and Toxicology Program.

**P&TX 731 (II): Advanced Pharmacology II- Cardiovascular and Renal System (Shi, Tracy)-2 credits**

A detailed study of the fundamentals of cardiovascular system, renal system and their pharmacology. The students will attend select P&TX 630 and 631 lectures and meet separately with the faculty for additional discussions of advanced material on the topics. The students will be examined on the advanced material.

**Prerequisite:** Graduate standing in Pharmacology and Toxicology Program.

**P&TX 732 (III): Advanced Pharmacology III- Immunology and Inflammatory Diseases (Moskovitz, Smith)-2 credits**

A detailed study of the fundamentals of inflammation, treatment for infectious disease & gastro intestinal pharmacology. The students will attend select P&TX 630 and 633 lectures and meet separately with the faculty for additional discussions of advanced material on the topics. The students will be examined on the advanced material.

**Prerequisite:** Graduate standing in Pharmacology and Toxicology Program.

**P&TX 733 (IV): Advanced Pharmacology IV- Endocrinology (Dobrowsky, Muma, Smith)-2 credits**

A detailed study of the fundamentals of endocrinology and associated pharmacology. The students will attend select P&TX 632 and 633 lectures and meet separately with the faculty for additional discussions of advanced material on the topics. The students will be examined on the advanced material.

**Prerequisite:** Graduate standing in Pharmacology and Toxicology Program.

**P&TX 740: Advanced Biotechnology (Dobrowsky, Yan, Rosa-Molinar)-3 credits**

An examination of basic principles of molecular biology, immunology, and protein chemistry as they apply to the identification, production, stability, delivery, and monitoring of new therapeutic agents provided by the expanding biotechnology industry. The students will be examined on the advanced material.

**Prerequisite:** Graduate standing in Pharmacology and Toxicology Program.

**P&TX 742: Experimental Pharmacology (Muma, Shi, Dobrowsky, Tracy) (Biyearly)-4 credits**

Experimental approaches to understanding the mechanisms of drug action. Use of drugs as tools to understand functioning of biological systems will also be stressed. Historically important experiments will be discussed along with experiments which are currently used to define drug mechanisms. Topics will include: pharmacokinetics, pharmacodynamics, drug receptor classes, and signaling pathways.

**Prerequisite:** Graduate standing in Pharmacology and Toxicology Program.

**P&TX 747: Molecular Toxicology (Rosa-Molinar, Tracy, Subramanian) (Biyearly)-2 credits**

A detailed study of the fundamentals of the experimental methods used in a modern toxicology laboratory. The students will attend P&TX 640 lectures and meet separately with the faculty for additional discussions of advanced material on the topics. The students will be examined on the advanced material.

**Prerequisite:** Graduate standing in Pharmacology and Toxicology Program.

**P&TX 799: Pharmacology and Toxicology Seminar (Muma) (every semester)-1 or 2 credits**

A review of the current literature and research in pharmacology and toxicology. Registration in P&TX 799 is required of all graduate students in the department every fall and spring semester prior to their official acceptance as a Candidate for the Doctoral Degree, which occurs after passing the comprehensive oral defense. Upon entering Candidacy for the Doctoral Degree and completing 18 hours of additional credits, students may then enroll for Dissertation Research only. However, it is expected that students continue to attend and participate in the journal club/seminar series each semester that they are in residence. Failure to comply may result in an unacceptable grade in Dissertation Research and potential loss of graduate standing.

**Prerequisite:** Graduate standing in Pharmacology and Toxicology Program.

**P&TX 800: Pharmacology and Toxicology Teaching Principles-2 credits**

This course is to be used by graduate students fulfilling the teaching requirements for the Ph.D. in pharmacology and toxicology. The student will function as a discussion leader and lecturer in a limited number of class sessions. Each student will meet with the faculty member whom he or she is assisting.

**Prerequisite:** Graduate standing in Pharmacology and Toxicology Program.

**P&TX 801: Issues in Scientific Integrity (Borchardt) (Biyearly)-1 credit**

Lectures and discussion on ethical issues in the conduct of a scientific career, with an emphasis on practical topics of special importance in molecular-level research in the chemical, biological, and pharmaceutical sciences. Topics will include the nature of ethics, the scientist in the laboratory, the scientist as an author, grantee, reviewer, employer/employee, teacher, student, and citizen. Discussions will focus on case histories.

**P&TX 803: Pharmacology Literature Review I (Muma) (Yearly)-1 credit**

This course is to be used by graduate students fulfilling the first written exam requirement for the Ph.D. in pharmacology and toxicology. The student will research and write a 6-page literature review by choosing a topic provided by the faculty.

**Prerequisite:** Graduate standing in Pharmacology and Toxicology Program.

**P&TX 804: Pharmacology Literature Review II (Muma) (Yearly)-1 credit**

This course is to be used by graduate students fulfilling the second written exam requirement for the Ph.D. in pharmacology and toxicology. The student will research and write a 12-page literature review by choosing a topic provided by the faculty.

**Prerequisite:** Graduate standing in Pharmacology and Toxicology Program.

**P&TX 741 Biomedical Statistics (Smith)- 3 credits (PLEASE NOTE THAT THIS COURSE IS TEMPORARILY BEING REPLACED BY PSYC 790 (for PhD students) & PSYC 791 (for both MS & PhD students))**

This course is primarily intended for students concerned with the analysis of experimental and observational data, with an emphasis on biomedical and pharmacological applications. The topics covered by the course include the design of experimental studies, data collection, probability theory, descriptive statistics, probability distribution, hypothesis testing, T-test, analyses of variance for factorial designs, linear and multiple regression, analysis of covariance and non-parametric methods.

**The courses listed below may be repeated during the graduate program based on the advice of each student's mentor.**

**P&TX 825: Research in Pharmacology and Toxicology (Primary Mentor)-3 credits minimum**

Original investigations at an advanced level in the areas of pharmacology or toxicology or related fields. This research will be performed by graduate students in collaboration with a faculty member.

**Prerequisite:** Graduate standing in Pharmacology and Toxicology program and consent of mentor.

**P&TX 899:** Master's Thesis (1-11) Hours and credit to be arranged. Independent investigation of a research problem of limited scope, leading to the preparation of a thesis.

**P&TX 999:** Doctoral Dissertation (1-11). Original laboratory investigations in pharmacology and toxicology. Results will be written as components of the dissertation

**The course listed below is an elective that a student may decide to take depending on his or her interests and the advice of their mentor.**

**P&TX 775 (3) Chemistry of the Nervous System.** A detailed study of the molecular aspects of neurotransmission will be covered with special emphasis on mechanisms of transmitter release, molecular basis of neuronal signal transduction, gene regulation in the nervous system, and mechanism of neurodegeneration.



## **B. Rotations, Financial Assistance, Graduate Student Travel Award, and Enrollment**

### Rotations

During your first semester in graduate school, you will participate in laboratory rotations. You will rotate through the laboratories of three different faculty members who will be potential mentors for your dissertation research. At the end of the rotations, you will inform the graduate program director of your first and second choices for a mentor. The graduate program director, together with the departmental faculty, will assist in matching students with mentors.

### Financial Assistance

During your first semester, your stipends will be provided by the department or a by a fellowship award. After your first semester, when you have chosen a mentor, your mentor will support you with his/her grant funds. Because of changes in budgetary appropriations at the federal level, a research grant held by a faculty member may expire. Consequently, if you are supported by a research grant, you may lose your source of financial support through your mentor. If this occurs, the department will make every effort to obtain other financial support for you. You will also be strongly encouraged to apply for various pre-doctoral fellowships and the faculty will help with this process.

### Graduate Student Travel Award

The department will accept applications from 4<sup>th</sup>-year students for a Graduate Student Travel Award, which may be used to support travel to present at a national/international conference of a scientific society or organization during the student's final year in the Ph.D. program. In order to be eligible for this award, students must be enrolled full-time in the P&TX Ph.D. program, have achieved doctoral candidacy, and have no other full travel funding from other sources. Students may receive only one award and applications must be submitted by March 15<sup>th</sup> of their penultimate year. Eligible students may submit an application containing their CV, unofficial transcript, abstract, event description, and a document summarizing their role in the research that they will be presenting, the impact of attending this conference on their professional development, and the relevance of the event to their area of study.

### Enrollment

The Graduate Studies Office requires that your enrollment in courses and research reflect the amount of faculty time you require and the facilities used for your training. In order to meet this requirement, the following procedure must be followed:

#### Before passing the Oral Comprehensive Exam

1. During the regular semester (fall and spring), the standard enrollment is nine (9) credit hours with a minimum of six (6) credit hours per semester.

2. During the summer session, the minimum or standard enrollment is three (3) credit hours per session.

#### After passing the Oral Comprehensive Exam

1. During this time, until all requirements for the degree are completed (or until 18 post-oral comprehensive exam hours have been completed, whichever comes first), you must enroll for a minimum of six (6) credit hours per semester (2 seminar + 4 dissertation research) and three (3) credit hours per summer session.
2. If the degree is not completed after 18 hours of post-oral comprehensive exam enrollment, you must continue to enroll each semester and each summer session until all degree requirements have been met. After all of the degree requirements are met and you have completed 18 hours of post-comprehensive degree credits, you may register for one (1) hour of dissertation supervision each semester. Credits obtained in the semester when the comprehensive oral exam is taken place may be counted toward the post-comprehensive requirement.

### **C. Advisory and Dissertation Committees**

Research Advisory Committee members for Ph.D. degree aspirants should be identified by the end of your second semester in the program. Your committee must be composed of at least three (3) members with the research director serving as chairman. You should meet with your advisory committee to present your research progress at least once a year, but preferably more often. This committee can be of great help to you in keeping your research project moving forward in a logical and timely fashion.

Once you have passed the oral comprehensive exam, you will become a “Candidate” for the Ph.D. and will need to form your dissertation committee. The final dissertation defense committee should consist of at least four (4) members of the graduate faculty in the Department of Pharmacology and Toxicology plus one (1) member of the graduate faculty at KU who is not a member of the Department of Pharmacology and Toxicology.

### **D. Changing Laboratories**

You may transfer labs before the end of the second semester of your first year, but after that you will need a major reason to request the transfer. Requests to transfer laboratories must be made in writing and will be reviewed and decided on by a faculty committee.

### **E. Written Cumulative Exams**

You will take a series of qualifying exams during your second, third and fourth semesters in the graduate program. These include two (2) written cumulative exams, preparation of an NIH-style research proposal, and an oral comprehensive exam. Written cumulative exams should be researched and written on your own time and not during the 7 – 8 hours you are working in the lab. The timelines for completion of these exams are detailed in the section entitled “Guidelines for Written Cumulative Exams.”

Your cumulative exam director will serve as your faculty liaison for your cumulative exams and grant proposal. Your cumulative exam director will receive all written exams, solicit reviewers, and prepare correspondence with you. All questions regarding the preparation and/or completion of the cumulative exams should be directed to your cumulative exam director. In brief, you will have four semesters to complete two written examinations and prepare and defend a grant proposal on an original research topic.

The two cumulative exams must be completed during your second and third semesters. Your first cumulative exam must be completed by the end of your second semester i.e., the spring semester. Your second cumulative exam must be completed by the end of your third semester, i.e., your second fall semester.

- 1) **Cumulative Exam 1**- You will be given a question by your supervisor. You will prepare a **6-page mini-review** on the topic. You may receive advice from your mentor. The cumulative exam should be completed and turned in to the cumulative exam director before the spring break of your second semester. If the review is not of sufficiently high quality, you will have one opportunity to remediate. Remediation should be based on feedback provided by the faculty and must be submitted before the end of the spring semester. If you do not successfully pass this exam, the faculty will meet to determine if you will continue in the graduate program.
- 2) **Cumulative Exam 2**- Once you begin your second year, you will receive one question from your mentor. You will prepare a short **12-page review** on the question. You may not receive advice from your mentor on this exam. You must complete and turn in your cumulative exam to your cumulative exam director before fall break. As with the first cumulative exam, if the review is not of sufficiently high quality, you will have one opportunity to remediate. Remediation should be based on feedback provided by the faculty and must be submitted before the end of the fall semester. If you do not successfully pass this exam, the faculty will meet to determine if you will be allowed to continue in the graduate program. You must successfully pass this exam before handing in your grant proposal.

In preparing your written cumulative exam you should include a section entitled **My Analysis** and give a critical analysis of the topic. This analysis should highlight your original and creative ideas and views, not those from a review article. For example, you might give your perspective on discrepancies in the field and why they may exist. You should include original and creative interpretations of the data, offer your perspective on the next most critical direction the field should take to significantly advance knowledge and show how these issues could be addressed experimentally. Highlight your original ideas and views, not just those from review articles. Adequate discussion in this section is critical to passing the second cumulative exam. Again, you will have one opportunity to remediate as described above.

**The cumulative exams are due on the last day of classes. Cumulative exams greater than five days past due will require a personal consultation between you, your advisor, your cumulative exam director and the department chair. A decision about your performance and further requirements will be ascertained at this meeting.**

## **F. Guidelines for Written Cumulative Examinations**

The following are guidelines for preparing your written answers for cumulative exam questions. These papers will be in the form of a "mini review" with a clear review of relevant literature, a discussion of the issues raised in the question, and outline of future experimental approaches to resolve issues that are currently not fully addressed.

Ideally, the answer should include four main sections.

### 1) Introduction

This section should introduce the question and the general manner in which you will address it.

### 2) Review of the current literature relevant to the question

This section is the "meat" and should include facts gleaned from the literature after the literature has been reviewed critically.

Facts should be organized into a format that is logical, progressive, and divided into sections. Each section should tell a story and be delineated as such with a heading and a short, interim conclusion. Where possible, each section should address a particular facet of the question.

Pay attention to items in the literature that disagree and delineate these in the text of the appropriate section. Try to note the minority opinion.

### 3) Conclusions

Draw appropriate conclusions relevant to the question and be especially critical regarding the literature you have reviewed. Note specifically:

- a) which facts don't agree
- b) which experiments draw interesting conclusions but may not have been conducted properly [for example, which experiments may have omitted appropriate controls]

### 4) Critical Analysis

In your new capacity as an expert:

- a) try to draw sufficient conclusions to formulate a hypothesis that explains the major facts
- b) propose experiments for the future or, at least, delineate the major questions that need to be addressed experimentally [even if current procedures will not allow specific experiments]

A strict page limit of either 6 or 12 double-spaced pages (excluding the list of references), written in normal type (compressed print and wide margins are not acceptable) will be enforced. The format to be used for references should include the names of all authors, the year, the title of the article, and the journal title, volume number, and beginning and ending pages.

STUDENT'S NAME \_\_\_\_\_  
REVIEWER: \_\_\_\_\_

DATE SENT: \_\_\_\_\_

### Evaluation Form for Written Cumulative Exams

Rating Scale:

- 1.0 – 1.5 = Outstanding
- 1.6 – 2.0 = Very Good
- 2.1 – 2.5 = Average
- 2.6 – 4.0 = Acceptable, but below expectations
- 4.0 – 5.0 = Unacceptable

Categories

#### A) Technical Aspects of Writing

- 1. Organization of Information (e.g., logical presentation, organized transitions between topics) \_\_\_\_\_
- 2. Clarity of Writing Style \_\_\_\_\_
- 3. Grammar, spelling, punctuation, consistency of form in citations, references \_\_\_\_\_
- Subtotal Section **A** \_\_\_\_\_

#### B) Intellectual/Scientific Content

- 1. Thoroughness of Literature Review, (e.g., depth of review, balanced presentation of opposing interpretations) \_\_\_\_\_
- 2. Integration of Information and Concepts (e.g., have main points been addressed, integrated and discussed in the broad perspective not as only isolated sections/topics) \_\_\_\_\_
- 3. Attempt at Critical Analysis (e.g., has student made solid and reasonable attempt to provide a cogent analysis) \_\_\_\_\_
- 4. Overall Assessment of Depth of Critical Analysis \_\_\_\_\_
- Subtotal Section **B** \_\_\_\_\_
- Total \_\_\_\_\_

Total should be no more than 15 points for acceptance without revisions.

Specific comments are helpful and may be directly on the paper.

## G. Preparation of an NIH-style Research Proposal

After successful completion of the second written comprehensive exam, you should begin working on your NIH grant proposal. This proposal will serve as the basis for your oral comprehensive exam. ***The written and oral defense of your grant should be completed by the end of your 4<sup>th</sup> semester of graduate residency and no later than July 1st.***

Consult with your graduate advisor before you begin to write your proposal. Once you and your advisor have agreed upon your topic, a research advisory committee made up of your graduate advisor and 2 additional faculty members will be chosen and they will initially evaluate your proposal. You will solicit this 3 member committee in consultation with your advisor. You will then select 2 additional members (who may be from outside the department) to serve on your full research advisory/dissertation committee. (Please note that the 3 members of the research advisory committee do not necessarily have to all come from P&TX, but that at least 3 members of the full dissertation committee must be P&TX faculty members.)

Your proposal will be based upon the NIH NRSA format and your research topic chosen may be identical to your dissertation research. First, prepare a 1-page synopsis of the rationale and specific aims of your proposal (a “Specific Aims” page – see page 16 of this handbook for more detail) for consideration by 3 committee members. After these faculty committee members agree that the proposal and specific aims are acceptable, you may begin writing your grant.

- 1) Meet with your advisor to discuss the possible topics, select one for your proposal, and set a date for convening with your comprehensive exam committee. Your committee should have the 3 members of your advisory committee plus 2 others (including someone from outside the department and someone who is designated to represent the Graduate Studies Office).
- 2) Obtain a copy of the NIH grant application form PHS 398 from the nih.gov website and use that format to plan an overview that you will present to your committee.
- 3) Develop a 1-page overview of your planned NIH proposal and present it to 3 members of your committee.
- 4) Read the instructions for completing the NIH application very carefully and prepare your proposed draft (see guidelines below). Give the proposal to 3 committee members who will function as your initial readers. They have 2 weeks to give you feedback for revising the proposal. You then need to complete the revisions and get the final proposal to all committee members. Your exam should be scheduled for about 2 weeks from the time your entire committee receives the proposal.
- 5) During your oral comprehensive exam, you will present and defend your research proposal. The other part of your exam will consist of questions about fundamental aspects of pharmacology, toxicology, and related areas that touch upon the work in your proposal.

## H. Guidelines for Preparing Your NIH Research Proposal

There really are only two essentials – a good idea and well written development of that idea.

### 1) A Good Idea

- a) Identify a well-defined, important problem – a problem whose solution would be of scientific and/or clinical significance. Trivial problems or reinventions of the wheel do not lead to interesting proposals.
- b) The problem must also lend itself to one or more experimental approaches, and the technology required to solve it should be available. Do not propose strategies for which methods have not yet been developed.
- c) The problem should be original, i.e., not just a different approach to a question that has already been addressed by others.
- d) Your approach to the problem should be logical, innovative, and ‘state-of-the-art’. Demonstrate that you have a very clear plan for attacking the problem and that you are very familiar with the best methodological tools available. Be sure the experiments address the problem you identified.
- e) It is important to show that you have a realistic grasp of what can be accomplished in the time allotted. Do not propose to do ten years-worth of work in three, nor draw one year worth of work out to three years.

### 2) Written Development of the Good Idea (The Proposal)

The comprehensive evaluation of your proposal and the general impression it makes on the reviewers will be due to many different factors which must come together in the final document you present. The overall significance of the problem and the originality, logic, and feasibility of your planned approach to the problem will form the basis for the final evaluation. Each section of the proposal should be designed to provide your reader with specific information that feeds into the total picture. Thus, a brief discussion of the most critical elements in each section follows. These are discussed in the order in which they occur in the application form, not necessarily in the order in which you will write the sections.

- a) Title – As the title plays a role in determining who the reviewers for your application will be (if it were being sent to NIH), it should accurately reflect the content of your proposal.
- b) Abstract of Research Plan – The abstract is a very brief statement of the most important components of the total proposal; namely, the significant problem you plan to study and the specific strategy you are going to follow. It is important that you clearly and succinctly indicate the overall



expected outcome of your studies and the ways in which these results are relevant to the NIH's goal of improving human health.

This will be your readers' first contact with your "good idea," and it is important that you use this space to state the problem clearly and succinctly. This is the point at which you must begin to persuade your readers that this is a significant problem and that you have developed a sound approach to solving it. Note that you must do this in a limited number of carefully chosen words! If your abstract does not make sense to the reviewer, his or her initial approach to the rest of the document will be colored by this sense of confusion.

- c) Specific Aims – Once you have developed specific ideas about how to approach the problem you have identified, you can prepare a draft of this part of the proposal. However, once you have completed a draft of the entire proposal, you will undoubtedly need to go back and modify this section to make sure it is completely consistent with the rest of your Research Plan. The "Specific Aims" should outline your concrete goals for each step of the project. Your project should be made up of discrete components that need to be undertaken in some prescribed sequence in order to achieve your overall objective. These "Specific Aims" should be presented in an outline form, preferably numbered, and limited to one page.
- d) Significance – This is the section in which you are expected to build the case for the problem you wish to study. This component requires that you make use of the existing literature to show precisely what gaps exist in our knowledge regarding the problem. You are setting the stage for the studies you plan to do and, thus, you must use the literature to frame the issues and thereby persuade your readers that these specific issues need to be addressed.

You must also persuade your readers that the resolution of the issues is important. The basis upon which you need to build the case for the significance of the problem will be determined to some extent by the nature of the problem you wish to pursue. Finding the answers to some questions may have dramatic clinical implications for a specific disease, while finding the answers to other questions may lead to a greatly enhanced understanding of a particular biological mechanism, and so on.

The principle for you to keep in mind is that you must provide your readers with pertinent background information and then develop your arguments about the problem in such a way that they will be compelled to agree with you. Be sure to cite the appropriate literature to document your major arguments and all statements of factual information. If you cite work that has produced results somewhat similar to the expected results of your projects, you must be very careful to describe exactly what new

information will be contributed by your studies and why your studies need to be done.

- e) Innovation – This section describes the ways in which the studies you propose are innovative. Innovation can be described at the level of techniques and approaches used in the proposed experiments. Most importantly, innovation must be described for the questions and hypotheses being addressed.
- f) Preliminary Studies – The requirement that you have preliminary data to support the feasibility of what you are proposing to do is theoretically “optional” for a new grant application. However, in practice this is generally not the case, and investigators are virtually always expected to have such data. That being said, you will probably not be able to provide some for this occasion.
- g) Experimental Design and Methods – This section provides you with the opportunity to tell your readers exactly how you are going to do what you are proposing to accomplish. This component is the heart of your proposal and must clearly grow out of the ground work you have laid in the earlier sections. Your “Specific Aims” should guide the organization of this section, but now you must provide a substantial amount of detail. Regardless of how you decide to organize this section, it is important that you include the following information:
  - i) A clear and thorough description of the approach you are going to take for each phase of the problem and the exact methods you plan to use. The more specialized or obscure the method, the more detail you will need to provide.
  - ii) Careful justification of your choice of a particular approach. Why is your approach better than other alternatives?
  - iii) A summary of the kinds of results you expect to obtain, and the methods you will use to analyze and interpret them, including mathematical, graphical, and statistical handling of your data.
  - iv) A discussion of alternative strategies you have thought of in case your results do not come out as expected. It is important to show your readers that you have considered the possibility that some things may not fall into place perfectly, and that you have already thought of alternatives that might be pursued.

The manner in which you present your “Experimental Design and Methods” section either convinces or fails to convince your reviewers that you have the ability to plan a sound method for attacking a problem, that you can anticipate potential difficulties and think of alternative strategies, and that you thoroughly understand the methodology you propose to use.

Your written proposal must reveal this, and you must also be prepared to defend your thinking at the time of your exam.

- h) Literature Cited – Follow the instructions in the application packet. The reviewers will check to make sure your literature citations are relatively recent. It is assumed you will be utilizing the most recent work in an area both to build your case and to plan your methodological approaches. Once you have a good draft of your proposal together, it would be wise to have at least one, two, or even three fellow students read it over before you give it to the initial readers on your committee. Ask your colleagues to read it primarily for clarity. The clarity and precision of your writing is considered to be a reflection of the clarity and precision of your thinking. Even if your colleagues are not familiar with the area, they should be able to give you valuable feedback on the organization of the information, presentation of the arguments, clarity of the writing, and accuracy of grammar, punctuation, etc. You should get in the habit of asking colleagues to read proposals for you before you send them out, as constructive local feedback can spare you many problems.

There should not be multiple typographical errors and other types of carelessness that can detract significantly from the overall proposal. Furthermore, there is an old adage about writing that is as true today as it ever was: “There is no such thing as good writing; there is only good rewriting.” Consequently, it is not unreasonable for readers to expect to receive documents that are clear, concise, polished, and error-free. The good draft of the proposal that you submit to the initial readers from your Committee should be well on its way to meeting those criteria.

## **I. Oral Comprehensive Exam**

After completing your grant application, you will submit it to the members of your research advisory committee. The committee will have two weeks to read your proposal and provide you with feedback. You will then have two weeks to rewrite your proposal and submit the revised document to your full dissertation committee. At this point, you should arrange a time and room for an oral defense of the proposal, allowing at least two weeks for the committee members to read and evaluate your proposal.

Once the date for your oral comprehensive exam has been scheduled, contact the department office or Graduate director at least two weeks prior to the defense date to request that your progress to degree form (PtD) be completed. The PtD forms are mandatory requirement by KU Graduate Studies Office. If not filled in time, your oral exam may be delayed or cancelled.

You will present a 45-50 minute seminar overviewing your proposal. The committee will question you on your grant proposal as well as other topics in pharmacology and toxicology, especially those related to your grant proposal. Following the oral comprehensive examination, you will be asked to leave the room and the committee will

deliberate on your performance. The committee will assign an outcome of honors, satisfactory or unsatisfactory based upon a simple majority vote.

The criteria for an honors designation rests solely with the committee but generally consists of the following:

- 1) demonstration of an outstanding depth of fundamental knowledge
- 2) ability to rapidly and logically reason through uncertainties with minimal cues from the committee
- 3) an exceptionally clear research proposal with well rationalized aims and clearly justified experimental approaches
- 4) excellence in orally defending the proposal

The criteria for a satisfactory designation rests solely with the committee but generally consists of the following:

- 1) demonstration of an acceptable depth of fundamental knowledge
- 2) ability to logically reason through uncertainties given sufficient cues from the committee
- 3) a clear research proposal with well rationalized aims and clearly justified experimental approaches
- 4) ability to orally defend weaknesses in the experimental rationales

The criteria for an unsatisfactory designation rests solely with the committee but generally consists of the following:

- 1) an unacceptable depth of fundamental knowledge
- 2) difficulty in being able to logically reason through uncertainties even with cues from the committee
- 3) a research proposal that, although acceptable, did not have clearly justified experimental approaches
- 4) poor oral defense of the experimental rationales

In the event of an honors or satisfactory decision, you will enter Candidacy for the Ph.D. In the event of an unsatisfactory performance, you may be given the option to receive an M.S. degree following the write-up and defense of a Master's thesis based upon the experimental work performed. Alternatively, you may submit a brief written petition to the department Chairman requesting a re-examination. This request should be no more than one paragraph and outline any extenuating circumstances or reasons you feel may have impacted your performance. This petition must be submitted within 3 days following notification of the outcome of the oral comprehensive examination.

In consultation with your mentor and departmental members of the examination committee, the Chairman will inform you within one week whether your petition is accepted or denied. If it is denied, you may complete the M.S. degree as outlined above. If accepted, you will reschedule another committee meeting no sooner than 90 days after the initial exam date but no later than 100 days after the initial exam date.

The second committee should be formed of five new faculty members. Your advisor will serve *ex officio* and be present during the examination to help clarify any scientific issues and inform the committee of the issues that led to the initial decision of unsatisfactory. If, following the second examination, you receive an honors or satisfactory decision, you will enter Candidacy for the Ph.D. A second unsatisfactory outcome cannot be appealed again and you may complete the M.S. degree as outlined above.

Upon passing the comprehensive oral examination, an aspirant for the Ph.D. degree becomes a “Candidate”, and a dissertation committee is appointed in accordance with Graduate School regulations. The dissertation committee normally consists of three members who serve as advisors for the completion of your dissertation research.

### **J. Post-Comprehensive Exam Enrollment**

After passing the comprehensive oral examination for a doctoral degree, the Candidate must be continuously enrolled, including summer sessions, until all requirements for the degree are completed. Additionally, each enrollment must reflect, as accurately as possible, the Candidate’s demands on faculty time and university facilities. During this time, until all requirements for the degree are completed (or until 18 post-comprehensive hours have been completed – whichever comes first), the Candidate must enroll for a minimum of **six credit hours a semester and three hours a summer session**. Once Candidates have completed 18 post-comprehensive exam credits, they are responsible for requesting to enroll in fewer than 6 credits. This requires the submission of a PtD form. Please contact the department administrative assistant.

### **K. Dissertation Research**

After choosing a research advisor, you will develop a dissertation project in consultation with your advisor.

Conducting research is the most important part of the graduate-training program. It is important for you not only to learn specific methods but also to understand and develop a rationale for experimental design. You should learn which experiments are worth doing and which ones you can predict will not give unequivocal answers. This goal will be accomplished by frequent consultation with your research advisor and your advisory committee. Following the oral comprehensive examination, you will present your dissertation research project to a 5-member advisory committee. You will also receive periodic advice from this committee throughout the execution of your project.

#### 1) Preparation of the Dissertation

**Prior to ceasing your experimental work and writing your dissertation**, your research advisory committee must agree that your body of work completed is sufficient for a dissertation. You will have already had several meetings with your advisory committee so that most of their suggestions will already have been carried out. Instructions regarding the proper form of the dissertation should be obtained from the Graduate School or the Pharmacy School Graduate Director.

Your advisor is responsible providing assistance and critical feedback on drafts of your dissertation as you write them.

## 2) Defense of the Dissertation

### a) Scheduling the Defense

When the final draft of your dissertation has been tentatively accepted by your research advisory committee, you may schedule the final oral defense of your work.

Once the date for your oral defense has been scheduled, contact the department office or Graduate director at least three weeks prior to the defense date to request that your progress to degree form (PtD) be completed. The PtD form is a mandatory requirement by KU Graduate Studies Office. If not filled in time, your oral defense may be delayed or cancelled.

### b) Final Dissertation Defense Committee

The committee for your dissertation defense shall consist of at least five members, all of whom are members of the Graduate Faculty. The committee members must be approved by the Graduate School prior to announcing your final defense. All members of the research advisory committee (official readers of the dissertation) must be present for your thesis defense. A grade of honors, satisfactory, or unsatisfactory will be assigned.

After your final dissertation defense has been successfully completed, the dissertation must be signed by the members of the dissertation committee. One bound copy of the dissertation must be given to the departmental office staff, and one bound copy must be presented to your research advisor. The finalized version of your dissertation must be turned in to the Graduate Director for the School of Pharmacy by the posted deadline. Degrees are awarded three times a year, in May, August, and December. However, the only doctoral hooding ceremony takes place on commencement day in May.

## MASTER OF SCIENCE DEGREE PROGRAM

The major aim of this Master's degree program is to train qualified graduates for careers in the fields of academia, industry, and government. The Master of Science in Pharmacology and Toxicology program builds students' research skills in molecular and neuro-pharmacology and in toxicology. In addition to the didactic component of our training, we view hands-on training in laboratory research as critical to the Master's thesis experience.

Candidates with a Bachelor's or Master's degree in chemistry, biology, pharmacology, toxicology, or other related disciplines are invited to apply. Applicants must demonstrate proficiency in verbal and written English and in fundamental scientific areas such as chemistry, biochemistry, or cellular and molecular biology. Admission criteria follow.

- 1) Overall grade point average (GPA) – A minimum GPA of 3.0 is required. Special attention is given to the grades achieved in science courses relevant to the program (e.g., cellular and molecular biology, biochemistry, pharmacology, toxicology, or statistics).
- 2) GRE score – A minimum combined GRE score of 950/290 in the Verbal and Quantitative areas is required.
- 3) TOEFL/IELTS scores for international applicants – A minimum score of 80 with Reading, Listening, and Writing part scores at least 20 is required for admission. IELTS-Academic requirement: minimum overall score 6.0 with no part score below 5.5.
- 4) Letters of recommendation – Three letters describing the student's ability and capability are required. It is preferable that these letters be written by faculty members, direct supervisors or instructors well-acquainted with your research and/or academic work. These letters should provide a thorough assessment of your experience in laboratory research, ability to communicate in verbal and written English, motivation and creativity, and other qualities of your academic performance.

Students accepted into the School of Pharmacy P&TX Master's program are not eligible for institutional financial aid. Students are not permitted to be paid for working in a lab while enrolled in research or thesis units.

The application deadline for admission in the fall semester is April 30th.

## A. M.S. Course Requirements

The department requires each M.S. student to take six courses, for a total of 18 credit hours, and maintain a cumulative GPA of a “B” or better. (Students are allowed to receive a grade of “C” in a maximum of 2 courses while they are enrolled in the program. After those 2 courses, students receiving a “C” will need to retake the course at their own expense).

### Required Core Courses

- P&TX 742: Experimental Pharmacology (4)
- P&TX 799: Pharmacology and Toxicology Seminar (4)
- P&TX 741: Biomedical Statistics (3)
- P&TX 740: Advanced Biotechnology (3)

### 4 credits in Advanced Pharmacology or Toxicology (2 courses)

- P&TX 730 (I): Advanced Pharmacology I- CNS and ANS (2)
- P&TX 731(II): Advanced Pharmacology II- Cardiovascular and Renal System (2)
- P&TX 732 (III): Advanced Pharmacology III- Immunology & Inflammatory Diseases (2)
- P&TX 733 (IV): Advanced Pharmacology IV- Endocrinology (2)
- P&TX 747: Molecular Toxicology (2)

## B. M.S. Research Requirements

Each M.S. student is required to take at least 12 credit hours for research in P&TX 825: Research in Pharmacology and Toxicology and P&TX 899: Master’s Thesis. Enrollment in P&TX 825 should continue till a thesis proposal is approved by your thesis committee. Then, enrollment in P&TX 899 must continue until a total of 12 credit hours for research are earned. Credits from didactic coursework and research/thesis supervision will add up for a total of 30 hours of graduate coursework.

M.S. students must to maintain continuous enrollment in the program until completion. The program allows a student to enroll in fewer than 9 credit hours (full-time credits) to meet the 30 hours required for the degree if thesis research is progressing well. It is expected that students will complete the requirements and graduate in two years. Please note the KU graduate school program time constraints policy below.

Students must write a thesis proposal in the form of a Specific Aims page and defend the proposal to their thesis committee by end of the spring semester of their first year. (If a student fails their Specific Aims defense, they have the opportunity to redo it and schedule another defense over the summer before the start of their second year). The thesis committee is composed of three faculty members in the department, the student’s mentor and two additional faculty agreed upon by the student and their mentor.

Students will be required to submit and defend a thesis resulting from research of sufficient originality and quality for publication in a peer-reviewed scientific journal. The



research will be conducted under the supervision and guidance from your advisor, with input from your thesis committee as needed.

Once the date for your oral defense has been scheduled, contact the department office or Graduate director at least three weeks prior to the defense date to request that your progress to degree form (PtD) be completed. The PtD form is a mandatory requirement by KU Graduate Studies Office. If not filled in time, your oral defense may be delayed or cancelled.

Top graduates, if interested, may transfer into the Ph.D. program in Pharmacology and Toxicology offered in the department.

### **C. Additional Requirements for the Ph.D. (for students who complete the Pharmacology & Toxicology M.S.)**

P&TX 700: Professional Issues in the Biomedical Sciences (2)

P&TX 800: Pharmacology and Toxicology Teaching Principles (2)

P&TX 801: Issues in Scientific Integrity (1)

P&TX 804: Pharmacology Literature Review II (1)

P&TX 799: Pharmacology and Toxicology Seminar (1 or 2 credits, taken every semester prior to passing the comprehensive exam)

Advanced Pharmacology and Toxicology courses not completed for the M.S. degree.

The Ph.D. will take a minimum of 3-4 years to complete after completion of the M.S. in Pharmacology and Toxicology.

### **D. Changing Laboratories**

M.S. students may transfer labs within the first semester. Requests to transfer laboratories must be made in writing and will be reviewed and decided on by a faculty committee.

### **E. Research Progress Checkpoints**

Checkpoint 1: M.S. students will present their research to the entire department at the beginning of the spring semester of their 2<sup>nd</sup> year. This presentation will be a 30-minute seminar for which they will be expected to practice ahead of time.

Checkpoint 2: M.S. students will meet with their committees and present their data before beginning to write the results portion of their thesis. Only after they have been given the go-ahead by their committee may they begin writing up their results.

Checkpoint 3: M.S. students will notify the department at least 2 weeks before they plan to hold their oral defense so that it can be scheduled their PtD form can be submitted. Students must submit their final thesis to their committee no later than 1 week before the oral defense. If any member of the committee deems the thesis unsatisfactory, the student will need to rewrite and the oral presentation will need to be postponed.

## SEMINAR GUIDELINES

The following paragraphs present a set of simple guidelines for your presentations in the departmental seminar course. These guidelines are designed to help you convey the maximum amount of information to the largest portion of the audience. While we recognize that other styles of presentation may be just as effective when used by some individuals, this format is functional for most people. For this reason, please adhere to this format in your presentation. These guidelines contain many things which seem obvious and which you may already have incorporated into your speaking style. Nevertheless, they serve to bring everyone to the same point and also serve as the framework the department uses during the critique following each presentation.

### A. REACHING THE AUDIENCE

- 1) Target your remarks so that they are comprehensible to anyone with a solid scientific background. The object is to convey information to the greatest number of people in the audience. While preparing your presentation, never say to yourself: "They ought to know this." Don't penalize anyone for a lack of knowledge.

Example: You are a pharmacologist and you must address your remarks to scientists from all biological fields. There may be molecular biologists/geneticists in the audience who have only rudimentary knowledge of pharmacology, toxicology, chemistry, neurophysiology and most other fields that are of daily currency to you. If you are a molecular biologist, bear in mind that your audience may not be prepared to receive a discourse on such subjects as transcriptional regulation, polymerase chain reaction or restriction enzyme technology without appropriate introduction.

- 2) Strive for clarity even if you need more words. Avoid jargon at all costs. In some instances, it may be necessary to use terms that a portion of the audience may not understand or discuss a particular chemical structure or DNA sequence that is necessary for the message you wish to deliver. In these cases, a list of such terms or structures should be visible at the corner of the blackboard throughout your talk.

#### Summary:

- Give an adequate introduction.
- NEVER USE JARGON
- Provide permanent definitions of specialized terms.

### B. THE BASIC UNIT OF THE PRESENTATION

Most people are aware that a good presentation consists of three basic elements: an introduction, a body, and a conclusion.

Please adhere to this structure for your presentation. In addition, each of these sections should be divided into the same three basic elements as well. That is, the introduction should not ramble along and grind to a stop. Rather, it should start with an introductory statement, followed by the background information that will be needed to understand the topic, and end with a conclusion and a statement of the problem or issue being investigated. Similarly, both the body and conclusion of the talk should each be divided into the three elements. Finally, the body of the talk consists of descriptions of data and presentation of figures. Each section of the body and, indeed, each figure should be described using the three basic elements of the talk.

Example:

1) Introduction to the Presentation

Always begin your presentation with a reiteration of the title followed by an enumeration of the authors and their affiliations. Remember, the work was done by people, not simply authors or “them”. Try to acquire a feeling for this that you can convey to your audience throughout the presentation. Think about how you would feel if someone was presenting your work in a similar situation. Reflect on how many times you would like to have your name mentioned in association with your work. Also, remember that the laboratories from which the work originated and the people who actually did the work are both important. [Example: Joseph Smith in Annie Herkheimer’s Lab]. When presenting papers that represent collaborative efforts, or when presenting work containing collaborations, make sure to be scrupulous in recognizing the work of others as well as their ideas and suggestions. Remember, credit for work and ideas is one of our prime goals.

2) State the Problem

[Example: “One of the most perplexing problems in the study of Lunar herbivores is that there exist no plants on the moon, yet numerous sightings of Lunar herbivores exist in the literature.”]

3) Body – Describe current literature (pro and con) which outlines the problem.

[Example: “Current evidence regarding the problem is as follows. The earliest report of Lunar herbivore activity was by Dr. M. Goose, who described the initial sighting and some follow up experiments. These experiments...”]

4) Conclusion of the Talk

- a) Restate the premise of the talk. [Example: “In this presentation, I have attempted to describe the work of Diddle et al., on the subject of Lunar herbivores. These authors addressed the following questions: ...”]
- b) Body of the conclusion. Re-emphasize the basic conclusions of the talk; describe any additional conclusions by the authors; relate the work

described to any other work you think is relevant (supporting, refuting, or elucidating the work you presented).

- c) Analysis of the Data. Restate the quality of the experimental design and the data and suggest alternative procedures or approaches.
- d) Final conclusion. Try to finish with a 'summing up' sentence or paragraph that should include future directions the work might take and the impact of the work on the field at large.

### Summary:

- Use the three basic elements everywhere.
- As Sidney Colowick once said: "Tell them what you're gonna tell them, tell them, then tell them what you told them."

## **C. DESCRIPTION OF FIGURES AND TABLES**

As mentioned above, each figure or table should be described according to the three basic units. Do not feel compelled to present all the figures and tables in the paper that you are discussing.

Four additional concepts to which you should pay attention are:

- 1) The transitional sentences
- 2) The description of methods
- 3) The physical description of figure axes or table columns
- 4) The statement of how many separate experiments the data represent and the statistical analyses used to evaluate the data.

### **1) Transitional sentence and introductory statement to Fig. 7:**

"Because of the results of the figure I just described, the authors felt it necessary to determine the kinetics of reappearance of herbivores from the backside of the moon. They are able to show that the mean time to traverse the backside of the moon included sufficient time for a stopover."

### **2) Method description for Fig. 7:**

"They used the following method to determine how much time elapsed between the disappearance behind the moon and the reappearance of the Lunar herbivore."

### **3) Description of axes for Fig. 7:**

Always describe the axes of a figure or the columns of a table before you begin to describe the data. Be certain that the audience has the tools to understand and interpret the data you are presenting before you present it.

“In the figure, the horizontal axis shows time elapsed from when the nose of the animal first passed behind the moon until the nose reappeared on the other side. The vertical axis represents the number of animals which fell into each time period.”

### **4) Description of data for Fig. 7:**

“The mean time in transit was 256 centons, a time corresponding to 1.83 X the mean orbit time. The authors indicate that this experiment was done three times per month over a period of one year, and that statistical analysis suggests...”

### **5) Conclusions regarding Fig. 7:**

“Thus, the results of this figure suggest additional time is elapsing while the animals are on the backside of the moon.”

### **6) Potential pitfalls of experimental design, data analysis, or conclusions drawn regarding Fig. 7:**

“Because the authors could not exclude possible diffraction changes in the images of the noses of herbivores, the exact timing of their disappearance and reappearance may be questioned. Therefore, an alternative procedure for measuring herbivore movements around the moon would be needed to confirm the apparent kinetics of their lunar existence.”

OR

“The methods of measurement and the data analyses were excellent and support the idea that movements of herbivores are an important component of their lunar existence.”

### Summary:

- Be sure one figure flows into the next; do not simply list them.
- State the reason the experiment was conducted.
- Describe how they conducted the experiment.
- Describe how the figure represents the data.
- State what the data shows.
- State the number of times each experiment was conducted.
- Outline their conclusions.
- Describe any experimental ambiguities and suggest any additional experiments.

## D. BASIC DOS

- 1) Dress appropriately for the presentation of your seminar. Dressing too casually may give off the wrong impression about the value you attach to this undertaking.
- 2) Speak loudly and with confidence so that everyone can hear your presentation.
- 3) Speak in short declarative sentences. For example, compare the following sentences both written and aloud:

“My finger was injured during a nail driving attempt when an important digit was forced into contact with the business end of the impacting tool resulting in acute discomfort.”

vs.

“I was using a hammer. I missed the target. I hit my finger. It hurts.”

- 4) If you prefer to write the seminar and then memorize and deliver it, remember that spoken language is different from written language. Do not write in passive voice and do not write complex sentences with more than one clause.
- 5) Use many visual aids. Begin with a slide. Always have something for the audience to look at, no matter what you are saying, even if the slide merely lists the points you are making. This tactic keeps people focused on your presentation.
- 6) Use the laser pointer from the department office.
- 7) Prepare your presentation with a “PowerPoint” type of format. Load it onto the computer you plan to use for the presentation and check to see that every slide projects appropriately with the equipment in current use in the lecture hall. A few minutes of planning will eliminate surprises or difficult moments during your presentation.
- 8) Make sure you have extra batteries for the laser pointer.
- 9) Make sure that you know the appropriate terminology, including singular and plural forms of Latin and Greek terms, e.g., medium vs. media, criterion vs. criteria, phenomenon vs. phenomena.
- 10) Write very brief, “bullet”, statements or questions on your slides.
- 11) Make sure figures and tables are readable from the back of the lecture hall.
- 12) Make eye contact with your audience. Do not speak to the board or projection screen or projector.

- 13) Please deliver the presentation to the whole audience. Do not elect a particularly attentive member of the audience or a personal friend and present the seminar to that person.
- 14) Try to speak without notes, or minimize your use of them as much as possible. Give the impression you are conversant with the subject. That being said, if you must choose between using notes to present the information well and not using notes (thereby giving a mediocre or bad presentation), by all means use the notes and give a good presentation.
- 15) When describing figures, always point to what you are describing at the time you are describing it.
- 16) Schedule at least one practice session with your advisor before the presentation. If you have difficulty arranging an audience, ask the seminar directors or your advisor and they will help you in organizing practice presentations.

## **E. BASIC DON'TS**

- 1) DO NOT attempt to present a surprise ending, no matter how much fun you think it might be. Rest assured, you will lose your audience during the buildup to the surprise.
- 2) Avoid shuffling through your notes or looking back through the figures you just showed. If you need to refer to it twice, show it twice.
- 3) Avoid obvious speech mannerisms, such as excessive use of vestigial syllables or words (i.e., “um”, “uh”, “you know”, “like”, “so”, etc.)
- 4) Avoid making a statement sound like a question by raising the tone of your voice near the end of the statement (“rising intonation”). This makes you sound less confident about the statement you just made.
- 5) Do not make up verbs from nouns. For example, there is an uptake process but not “to uptake or uptaken.” There is a flux but not “to flux or it fluxes.” There is an impact of something but not “to impact or impacted”.
- 6) Do not point the laser pointer toward the audience!
- 7) Try to avoid mannerisms that might distract the audience and cause them to lose concentration.
- 8) Don't fidget with the pointer, your clothes, hair, or anything else on your person or equipment.
- 9) Don't jingle the change in your pocket.

- 10) If you must check the time, arrange to do it unobtrusively. If you look at your watch, your audience will do so as well. Since this process usually occurs near the end of the hour, there is a strong likelihood that delivery of a very important concept will be disrupted.
- 11) DO NOT be flippant or assume the role of a stand-up comedian. Humor can be helpful, but be very careful how you use it. Display the proper respect for the audience you are addressing at all times.
- 12) ☺ **Most importantly, have fun and enjoy the intellectual challenge of assimilating, presenting, and interpreting information.**



## CRITICAL ANALYSIS OF DATA

The following comments are presented in order to give you a working definition of what the department means by the statement of “Critical Analysis of Data.”

What is critical analysis and how does it differ from gathering and disseminating information?

- 1) Critical analysis of an experiment involves a systematic dissection of how information was obtained and how evidence was pieced together to support or refute a point of view.
- 2) Critical thinking about any experiment is not achieved instantaneously nor is it usually taught in classes. It is the result of continuous training, practice, and a willingness to be intellectually alert and honest.
- 3) Critical analysis of data depends on having a large base of information, but it goes beyond that. It depends on being skilled in science, but it goes beyond mere laboratory skills.
- 4) Critical analysis of experiments requires the use of scientific information and skill in the laboratory to question the premises under which an experiment is performed.
- 5) Above all, critical analysis of experimental design and data requires a willingness and desire to reject ideas not supported by experimental manipulations.

## CRITERIA FOR DEMONSTRATING CRITICAL ANALYSIS OF DATA

How do we determine if someone is thinking critically about an experiment? We examine whether the following goals have been accomplished:

- 1) A hypothesis based on existing, valid, and well-documented facts was formulated.
- 2) The hypothesis is internally consistent and logical.
- 3) The hypothesis is testable, i.e. one can design appropriate experiments to test it.
- 4) A clear and logical experimental approach to test the hypothesis has been chosen.
- 5) A precise description of all possible experimental outcomes has been presented; both those supporting and those refuting the hypothesis.
- 6) A clear presentation of the data has been made, including:
  - a) Appropriate controls
  - b) Number of repetitions
  - c) Statistical analysis
  - d) Limits of the precision of the techniques used
  - e) Reproducibility and internal consistency of the measures used
- 7) The experimental outcome is compared to outcomes from other experiments reported in the literature.
- 8) A strong effort is made to provide as many alternative explanations for the experimental outcomes as possible, including explanations that may not fit or support the original hypothesis.
- 9) A clear description of the experimental design is presented to address each of the alternative explanations. OR, a clear description of the literature is used to effectively argue against such alternatives.
- 10) A cautious statement is made to accept or modify the original hypothesis OR additional experimental approaches are proposed to test the hypothesis further.
- 11) An outline of possible limitations of the study is presented.

## **A CHECKLIST FOR CRITICAL ANALYSIS AND GOOD REASONING**

### **1) All reasoning has a PURPOSE.**

- State your purpose clearly.
- Distinguish your purpose from related purposes.
- Check periodically to make sure you're still on target.
- Choose significant and realistic purposes.

### **2) All reasoning is an attempt to FIGURE something out, settle some QUESTION, and solve some PROBLEM.**

- State the question at issue clearly and precisely.
- Express the question in several ways to clarify its meaning and scope.
- Break the question into sub-questions.
- Distinguish questions that have definitive answers from those that are a matter of opinion and those that require consideration of multiple viewpoints.

### **3) All reasoning is based on ASSUMPTIONS.**

- Clearly identify your assumptions and determine whether they are justifiable.
- Consider the ways in which your assumptions shape your point of view.

### **4) ALL reasoning is done from some POINT OF VIEW.**

- Identify your point of view.
- Seek other points of view and identify their strengths and weaknesses.
- Strive to be fair-minded in evaluating all points of view.

### **5) All reasoning is based on DATA, INFORMATION & EVIDENCE.**

- Restrict your claims to those that are supported by the data you have.
- Search for information that opposes your position as well as information that supports it.
- Make sure that all information you use (including data) is clear, accurate, and relevant to the question at hand.
- Make sure that you have gathered sufficient information/data.

### **6) All reasoning is expressed through and shaped by CONCEPTS and IDEAS.**

- Identify key concepts and explain them clearly.
- Consider alternative concepts or alternative definitions of concepts.
- Make sure that you are using concepts with care and precision.

### **7) All reasoning contains INFERENCES or INTERPRETATIONS by which we draw CONCLUSIONS and give meaning to data.**

- Infer only what the evidence implies.
- Check inferences for their consistency with each other.
- Identify assumptions that lead you to your inferences.

8) **All reasoning leads somewhere or has IMPLICATIONS and CONSEQUENCES.**

- Trace the implications and consequences that follow from your reasoning.
- Search for negative as well as positive implications.
- Consider all possible consequences.

## WHAT YOU NEED TO ADDRESS IN A PRESENTATION PAPER

<b>PURPOSE:</b>	<p>What am I trying to accomplish?</p> <p>What is my central aim?</p> <p>What is my purpose?</p>
<b>QUESTIONS:</b>	<p>What question am I raising?</p> <p>What question am I addressing?</p> <p>Am I considering the complexities in the question?</p>
<b>INFORMATION:</b>	<p>What data/information am I using in coming to a conclusion?</p> <p>What experience have I had to support this claim?</p> <p>What information do I need to settle the question?</p>
<b>INFERENCES/ CONCLUSIONS:</b>	<p>How did I reach this conclusion?</p> <p>Is there another way to interpret the information?</p>
<b>CONCEPTS:</b>	<p>What is the main idea here?</p> <p>Can I explain this idea?</p>
<b>ASSUMPTIONS:</b>	<p>What am I taking for granted?</p> <p>What assumption has led me to this conclusion?</p>
<b>IMPLICATIONS/ CONSEQUENCES:</b>	<p>If someone accepted my position, what would be the implications?</p> <p>What am I implying?</p>
<b>POINTS OF VIEW:</b>	<p>From what point of view am I looking at this issue?</p> <p>Is there another point of view I should consider?</p>

## TEMPLATE FOR ANALYZING THE LOGIC OF AN ARTICLE CHOSEN FOR PRESENTATION

1) The main Purpose of this article is

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(State as accurately as possible the author's purpose for writing the article.)

2) The key question that the author is addressing is

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(Figure out the key question in the mind of the author when she/he wrote the article.)

3) The most important information in this article is

---

(Figure out the facts, experiences, data the author comes to and present in the article.)

4) The main inferences/conclusions in this article are

---

(Identify the key conclusions the author comes to and presents in the article.)

5a) The key concept(s) or experimental strategies we need to understand in this article is (are)

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5b) By these concepts the author means

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(Figure out the most important ideas or experimental strategies you would have to understand in order to understand the author's line of reasoning and conclusions.)

6) The main assumption(s) underlying the author's thinking is (are)

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(Figure out what the author is taking for granted [that might be questioned].)

7a) If we take this line of reasoning seriously, the implications are

---

(What consequences are likely to follow if people take the author's line of reasoning seriously?)

7b) If we fail to take this line of reasoning seriously, the implications are

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(What consequences are likely to follow if people ignore the author's reasoning or accept an alternative reasoning?)

8) The main point(s) of view presented in this article is (are)

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(What is the author looking at, and how is she/he seeing it?)

## CRITERIA FOR EVALUATING THE REASONING/CRITICAL ANALYSIS OF INFORMATION IN A PRESENTATION

- 1) **PURPOSE:** What is the purpose of the reasoner? Is the purpose clearly stated or clearly implied? Is it justifiable?
- 2) **QUESTIONS:** Is the question well-stated? Is it clear and unbiased? Does the expression of the question do justice to the complexity of the matter? Are the question and purpose directly relevant to each other?
- 3) **INFORMATION:** Does the presenter cite relevant evidence, experiences, and/or information essential to the issue? Is the information accurate? Does the presenter address the complexities of the issue?
- 4) **CONCEPTS:** Does the presenter clarify key concepts when necessary? Are the concepts used justifiably?
- 5) **ASSUMPTIONS:** Does the presenter show sensitivity to what he or she is taking for granted or assuming? (Insofar as those assumptions might reasonably be questioned?) Does the presenter use questionable assumptions without addressing problems that might be inherent in those assumptions?
- 6) **INFERENCES:** Does the presenter develop a line of reasoning that explains well the ways in which she/he is arriving at her/his main conclusions?
- 7) **POINT OF VIEW:** Does the presenter show sensitivity to alternative relevant points of view or lines of reasoning? Does he/she consider and respond to objections framed from other relevant points of view?
- 8) **IMPLICATIONS:** Does the presenter show sensitivity to the implications and consequences of the position she/he is taking?

## POINTS TO REMEMBER IN PREPARING A SEMINAR PAPER

<b>CLARITY</b>	<p>Should I elaborate further?</p> <p>Should I give an example?</p> <p>Should I illustrate what I mean?</p>
<b>ACCURACY</b>	<p>How can I check on that?</p> <p>How can I find out if that is true?</p> <p>How can I verify or test that?</p>
<b>PRECISION</b>	<p>Can I be more specific?</p> <p>Can I give more details?</p> <p>Can I be more exact?</p>
<b>RELEVANCE</b>	<p>How does that relate to the problem?</p> <p>How does that bear on the question?</p> <p>How does that help me with the issue?</p>
<b>DEPTH</b>	<p>What factors make this a difficult problem?</p> <p>What are some of the complexities of this question?</p> <p>What are some of the difficulties we need to deal with?</p>
<b>BREADTH</b>	<p>Do I need to look at this from another perspective?</p> <p>Do I need to consider another point of view?</p> <p>Do I need to look at this in other ways?</p>
<b>LOGIC</b>	<p>Does all this make sense together?</p> <p>Does my first statement fit in with my last?</p> <p>Does what I say follow from the evidence?</p>
<b>SIGNIFICANCE</b>	<p>Is this the most important problem to consider?</p> <p>Is this the central idea to focus on?</p>



	Which of these facts are most important?
<b>FAIRNESS</b>	Is there a vested interest in this issue? Were the viewpoints of others presented fairly?