

Comprehensive Examination

After the requirements of the Qualifying Examination have been fulfilled, the Comprehensive Examination is the major requirement that a student must pass before being admitted to formal candidacy for the Ph.D. degree. For scheduling requirements of the Graduate College, students are advised to consult the Graduate Program Coordinator and the Graduate College publication "Program Requirements" (http://grad.arizona.edu/Current_Students/Program_Requirements/). Forms required by the Graduate College must be electronically submitted to the Graduate Degree Certification Office ("login to My GradColl": <https://grad.arizona.edu/gc/>) at least 7 working days prior to the proposed oral exam date.

The Comprehensive Examination is considered a single examination, although it consists of written and oral parts that are both designed to meet two main objectives:

- To evaluate the proficiency of the student's general neuroscience knowledge
- To evaluate the ability of the student to:
 - independently evaluate and critique a body of neuroscience literature,
 - integrate the acquired information into broad conceptual schemes,
 - develop testable hypotheses,
 - devise experimental approaches and thereby evaluate hypotheses,
 - demonstrate the communication skills required to present and defend scientific ideas in oral and written formats.

The Comprehensive Examination must be taken in the student's fourth or fifth semester in the Program. The EC may only grant an extension for compelling reasons upon written petition from the student's Advisory (Dissertation) Committee.

A revised format of the "Guidelines for the Comprehensive Examination" was approved in December 2007. For a transition period of up to 2 years (12/31/2009), a student is free to choose between the new (Format A) and the previous exam format (format B). A revision of Format A was approved on 6/10/2009, and is effective immediately.

Format A

Overview. Students will prepare a mock research proposal (written exam). The oral exam will consist of an in-depth examination of the topic addressed in the research proposal and a broad examination that can cover any aspect of neuroscience and/or the chosen minor field of study.

The topic of the research proposal can be any problem of neuroscience, and may or may not be part or the focus of the student's planned dissertation research. However, overlap of the research proposal with specific aims of existing grant applications or projects (past, current or in draft form) is not permitted.

The emphasis of the research proposal should not be on a review of the literature but on dealing creatively with the problem selected. The proposal should be "hypothesis-driven". That is, it should aim explicitly to address a working hypothesis regarding an unresolved issue in Neuroscience.

The Comprehensive Examination will evaluate the written proposal, its oral defense, and fundamental knowledge in all basic areas of neuroscience. All three parts must be mastered independently. The broadly covered areas should include aspects of molecular/cellular, developmental, systems, behavioral, computational neuroscience or medical neuroscience. It is expected that many students may use their written research proposal as a template for future fellowship applications.

Comprehensive Exam Committee. By the end of the first year in the program, the student selects an Exam Committee, which will conduct the comprehensive examination. After the comprehensive exam,

the Exam Committee may then be re-structured to serve as Dissertation Committee (for details, see section Dissertation Committee).

The Exam Committee should consist of at least 4 members, including at least 3 members of the GIDP Faculty (one of whom can be the Dissertation Advisor) and one faculty member from the student's minor field. Note that since GIDP faculty may also be associated with the minor program, more than 3 members of the committee may belong to the GIDP. One of the GIDP faculty members other than the Dissertation Advisor will serve as chairperson, and will preside over all examinations and deliberations of the committee. The Exam Committee has the flexibility to make the best decision for a given student

Initial Preparation. The student must convene an initial meeting with the committee to select:

- a specific topic for the research proposal
- date for submission of research proposal (written examination): 8 weeks after initial meeting
- date for oral examination: 10-12 weeks after initial meeting

Prior to the first meeting, the student submits 1 pre-proposal to the committee (one page). The pre-proposal should outline a rationale for the topic/problem to be studied, and at least 3 questions (future Aims) that will be addressed later in the proposal. The questions raised in the pre-proposal must allow the student to develop and address a working hypothesis regarding an unresolved issue in Neuroscience. The pre-proposal should reflect an informed analysis of the problem and the relevant literature, and should be supported by key citations.

The proposed topic may, or may not be part, or the focus of the student's planned dissertation research. However, any overlap of the research proposal with specific aims of existing grant applications or projects (past, current or in draft form) are not permitted. If indicated, the Committee may consult CRISP (Computer Retrieval of Information on Scientific Projects), which is a searchable database of federally funded biomedical research projects conducted at universities, hospitals, and other research institutions. Additionally, the Committee may request copies of relevant grant applications from the Dissertation Advisor.

At the first committee meeting, the committee must evaluate whether the topic and the outlined questions of the proposal are appropriate to design a hypothesis-driven research proposal. The committee chair is charged with ensuring that such an evaluation has been carried out and that appropriate dates for the written and oral exam (see time line) have been selected.

Before and during the preparation of the proposal, the student may have general discussions on background information, or the strengths and weaknesses of experimental approaches and techniques with members of the Exam Committee or the Dissertation Advisor but NOT with other colleagues. It is not appropriate to ask anybody for review of any parts of the written proposal, even in draft form. The written proposal must be entirely the work of the student. It is not permitted to use any part of an existing research proposal (being past, current or in draft form).

Timeline.

- Initial committee meeting and identification of a specific topic for the research proposal (ideally during the fourth, the latest by the end of the fifth semester)
- Deadline for submission of research proposal (time of written exam): 8 weeks after initial committee meeting
- Announcement of written exam evaluation: no later than 1 week after submission of the proposal.
- Oral examination: 10-12 weeks after initial committee meeting (2-4 weeks after submission of the proposal)

Written Exam. After selection of the specific research topic, the student will have 8 weeks to write a mock grant application based on the selected problem. The student will need to evaluate the literature in

the selected area, formulate significant and relevant hypotheses, and devise experimental strategies to test hypotheses.

The emphasis of the research proposal should not be on a review of the literature but on dealing creatively with the problem selected. The proposal should aim to explicitly address a working hypothesis regarding an unresolved issue in Neuroscience. There is an expectation of substantial depth of knowledge in the research area per se. It will not be sufficient to defend only the particulars of the proposed experiments. A key element of the proposal defense will be to explain and defend the importance of the questions to be addressed, and to place these questions in the broader context of the field. Thus, in both the significance section of the written proposal and in the subsequent oral defense, the student should be able to marshal knowledge from the relevant literature and from broader areas of Neuroscience.

The research proposal should follow the basic form of an NIH Predoctoral NRSA grant application. The proposal should realistically cover 3 years of research.

The guidelines for the written proposal are those used for the standard NRSA grant application format (PHS 416 at <http://grants.nih.gov/grants/funding/416/phs416.htm>). The only distinction from NRSA guidelines is that the page limit for the research proposal of the comprehensive exam is twenty 1.5-spaced pages, including all figures and tables. NOTE that the bibliography does not count as part of the page limit. The limits on font size, margins and document length must be followed.

The research proposal must include the following sections:

Specific Aims (1 page max.): This section should include a concise statement of what the proposed research is intended to accomplish and/or what hypothesis is to be tested. It also lists the aims (2-3) of the proposal and brief statements of how each aim will be addressed.

Background and Significance (~8 pages): The section should include a concise presentation of pertinent literature in the chosen area of interest. It is expected that the relevant literature is critically and scholarly evaluated in substantial depth such that specific gaps are identified that the proposal can intend to fill. This section should also include a statement regarding the significance of the proposed research (1-2 paragraphs).

Rationale (1 page max.): Description of links between background, hypothesis, and specific aims; brief justification of general experimental approaches in relation to the questions of the proposal.

Preliminary Results: A description of preliminary results is not required but may be added at the discretion of the student and the Exam Committee. This description is restricted to maximal 2 pages.

Research Plan (~10 pages): Description of experiments that are proposed to achieve the research goals of the proposal. This section should place less emphasis on methodological details and more emphasis on anticipated outcomes and potential experimental pitfalls. The experimental plan should also accommodate unexpected findings and alternative strategies should be identified. Experiments for each of the proposed aims should be discussed in the order listed in the specific aims section. This discussion should include:

- Discussion of experimental or other procedures and their advantage over alternative methodologies. Brief description of any new and non-standard methodology.
- Description of means by which the data will be analyzed and interpreted.
- Discussion of possible results, both positive and negative, and an interpretation of different outcomes.
- Discussion of potential difficulties and limitations of the proposed experiments and identification of alternative approaches that might be taken to achieve the aim.

References (not part of the page limit): Full citations of all referenced literature must be included. Any format of in-text citations can be used. In the bibliography each literature citation must include the names of all authors, the year of publication, the title of the publication, the name of the book or journal, volume number, and page numbers.

Students are encouraged to look at actual grant applications submitted by their advisor, other committee members or students to get a sense of what is included in an application. However, students are not allowed to receive assistance with written drafts of their exam or guidance in the construction of the proposal.

The degree of any third person's involvement in developing the hypothesis, any of the proposed experiments, or possible conclusions must be stated at the end of the research proposal. Additionally, the student must certify that nobody else than the student reviewed any parts of the written proposal, and that the written proposal is entirely the work of the student.

As mentioned above, general discussions on background information, or the strengths and weaknesses of experimental approaches and techniques are permitted with members of the Exam Committee or the Dissertation Advisor but NOT with other colleagues. However, such discussions must be briefly described in the above statement.

The written exam (research proposal) must be electronically submitted to the chair of the committee within 8 weeks after the initial meeting (preferably as a pdf file).

Evaluation

The student's research proposal will be immediately distributed to all committee members for their evaluation, using the following criteria:

- Expectation that pertinent literature in the chosen area of interest is presented in substantial depth and that the addressed problem is presented in relation to a wider context ("big picture").
- Expectation that the existing knowledge is critically and scholarly evaluated such that specific gaps in our knowledge are identified.
- Expectation that hypothesis-driven approaches are proposed and that the logic connecting the hypothesis, experiment approaches, experimental outcomes, and possible conclusions is clearly developed and presented.

Each committee member will submit a letter grade of A (4), B (3), C (2), D (1), or F (0) to the committee chair to calculate an average score. An average score of 3.0 or higher will be necessary and sufficient for the student to pass the written section of the examination.

Additionally, committee members are asked to provide constructive and useful written feedback to the student regarding major weaknesses of the proposal. The chair of the committee will compile these comments and transmit them to the student together with the average grade.

The chair of the committee will notify the student, the other members of the committee, and the chair of the GIDP of the outcome within 1 week of submission of the proposal. The student must have passed the written examination in order to proceed to the oral examination.

At the discretion of the committee, a student who fails the written examination may be permitted to repeat the examination once. It is also at the discretion of the student's committee to decide whether the student will be permitted to revise and resubmit the failed proposal, or whether the student must submit a new proposal on a different research topic. A repeated written examination must be completed within 5 months after the first examination.

A student with an average of 1.0 or lower shall not be allowed to repeat the examination. In this case, the student will be dismissed from the program.

Oral Exam. The oral part of the comprehensive examination should be taken as soon as possible, and no longer than 4 weeks after successful completion of the written examination. At least 7 working days

prior to the proposed date, the form entitled "Application for Oral Comprehensive Examination for Doctoral Candidacy" must be electronically submitted to the Graduate Degree Certification Office ("login to My GradColl": <https://grad.arizona.edu/gc/>).

The oral examination involves two parts:

- **in-depth questions** within the area of specialization (topic of research proposal but also dissertation research, if different)
- **broad questions** across the general field of neuroscience (including molecular/cellular, developmental, systems, behavioral, computational and/or medical neuroscience).

The student may initially give a 5-10 minute overview of the research proposal using audio-visual materials. A LCD projector and, if needed, a laptop computer will be made available for the exam. The first 30-45 minutes (including presentation) of the oral exam may be devoted to the defense of the research proposal. The remaining time consists of a broad examination covering any aspect of neuroscience and/or the chosen minor field of study. The exam must last a minimum of 2 hours but cannot exceed 3 hours.

Students are advised to have at least one practice oral exam with other graduate students and postdocs about two weeks before the scheduled exam. This can be helpful in identifying strengths and weaknesses since students often need practice to effectively illustrate answers to posed questions on a black board.

Evaluation

The student is expected to master both parts of the oral exam and show:

a) solid in-depth knowledge within the area of specialization. There is an expectation of substantial depth of knowledge on the topic of the written proposal (and topic of dissertation, if different). It will not be sufficient to defend only particulars of the proposed experiments. A key element of the defense will be to explain and defend the importance of the addressed questions, and to place these questions in the broader context of the field. It is also expected that the student will, in a scholarly manner, address questions concerning background information relevant to the topic, significance, and design of the proposed experiments.

b) general knowledge of the major and minor subjects of study. The student is expected to demonstrate a solid, general knowledge of fundamental principles in all areas of neuroscience, including molecular, cellular, developmental, systems, behavioral, computational and disease-orientated neuroscience. A similar solid general knowledge of fundamental principles is expected for the respective minor field of study.

Failure to meet one of the expectations (a or b) results in failure of the entire oral exam. Failure to meet one part cannot be substituted by an excellent performance in the other part.

After no more than 2 hours into the exam, the student will be briefly excused from the room and the committee will discuss the student's performance. At this time, the committee may decide that the student has either passed or failed the exam, or it may decide that the examination should continue with additional questions. If continued, the chair is charged to ensure that the exam time is limited to three hours, by which time the committee must decide on a pass or fail grade. Committee deliberation time is not included in the exam time.

If a student fails the oral examination, the committee may recommend that the student be dismissed from the Program or be re-examined no later than six months from the date of the failed oral examination (provided that the student is not already on probation and has not taken the written exam twice). Failure to pass the oral comprehensive exam within six months of the original date will be grounds for dismissal from the program.

After successful completion of the comprehensive exam, the student will be promoted from Graduate Assistant to Graduate Associate (effective the next January 1 or July 1). The student must then apply for Advancement to Candidacy. This application must be submitted before the student may enroll in NRSC 920, Dissertation Research. At least 18 units are required, with no more than 9 being taken in any one semester.