GEORGE MASON UNIVERSITY
Graduate Council NEW Certificate, Concentration, Track or Degree Program
Coordination/Approval Form

(Please complete this form and attach any related materials. Forward it as an email attachment to
the Secretary of the Graduate Council. A printed copy of the form with signatures should be
brought to the Graduate Council Meeting. If no coordination with other units is requires, simply
indicate “None” on the form.

Title of Program/Certificate, etc: Neuroscience

Level (Masters/Ph.D.): Ph.D.

Please Indicate: X Program  Certificate   Concentration   Track

Description of certificate, concentration or degree program:
Please attach a description of the new certificate or concentration. Attach Course Inventory
Forms for each new or modified course included in the program. For new degree programs,
please attach the SCHEV Program Proposal submission.

Please list the contact person for this new certificate, concentration, track or program for
incoming students:

Dr. Peter A. Becker, Associate Professor, Associate Dean for Graduate Studies, School of Computational
Sciences 703-993-3619

Approval from other units:

Please list those units outside of your own who may be affected by this new program. Each of
these units must approve this change prior to its being submitted to the Graduate Council for
approval.

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Submitted by: _____________________________________________ Email: ____________

Graduate Council approval: _________________________________ Date: ____________

Graduate Council representative: ___________________________ Date: ____________

Provost Office representative: _____________________________ Date: ____________
STATE COUNCIL OF HIGHER EDUCATION FOR VIRGINIA

PROGRAM PROPOSAL COVER SHEET

<table>
<thead>
<tr>
<th>1. Institution: George Mason University</th>
<th>2. Program action (Check one):</th>
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<td>Spin-off proposal</td>
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<th>3. Title of proposed program: Ph.D. in Neuroscience</th>
<th>4. CIP code: 30.2401</th>
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<th>5. Degree designation: Ph.D.</th>
<th>6. Term and year of initiation: Fall 2004</th>
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<th>7. Term and year of first graduates: Spring 2006</th>
<th>8. For community colleges: date approved by local board</th>
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<tr>
<th>9. Date approved by Board of Visitors:</th>
<th>10. For community colleges: date approved by State Board for Community Colleges</th>
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11. If collaborative or joint program, identify collaborating institution(s) and attach letter(s) of intent/support from corresponding chief academic officers(s): The degree is offered only by George Mason University.

12. Location of program within institution (complete for every level, as appropriate). If any organizational unit(s) will be new, identify unit(s) and attach a revised organizational chart and a letter requesting an organizational change (see Organizational changes--hotlink). School(s) or college(s) of School of Computational Sciences; College of Arts & Sciences; Krasnow Institute for Advanced Study
Campus (or off-campus site) Fairfax campus
Distance Delivery (web-based, satellite, etc.)

13. Name, title, telephone number, and e-mail address of person(s) other than the institution’s chief academic officer who may be contacted by or may be expected to contact Council staff regarding this program proposal:
Dr. Dr. James L. Olds, Professor, Director of the Krasnow Institute for Advanced Study 703-993-4378
Dr. Peter A. Becker, Associate Professor, Associate Dean for Graduate Studies, School of Computational Sciences 703-993-3619
A Proposal for a Ph.D. in Neuroscience

presented by

the College of Arts and Sciences,
the School of Computational Sciences,
and the Krasnow Institute,
George Mason University

October 7, 2003
SUMMARY

The College of Arts and Sciences (CAS), the School of Computational Sciences (SCS), and the Krasnow Institute for Advanced Study at George Mason are proposing a new PhD program in neuroscience. The proposed PhD combines and extends the existing Neuroscience concentration in the CAS Biosciences PhD, and the Computational Neuroscience concentration in the SCS Computational Sciences PhD. Neuroscience constitutes one of the fastest growing and most popular branches of science. George Mason has a significant number of faculty and researchers in neuroscience scattered among several subdivisions of the University. The proposed program brings together those faculty to produce a PhD program that is stronger than the sum of the two degree programs it replaces. The curriculum provides fundamental concepts common to both existing degree programs, exposes students to multidisciplinary approaches, and instills an early appreciation of collaborative efforts. At the same time, the program is characterized by a unique strength in selected areas of system and integrative neuroscience, both in terms of approaches (e.g. behavioral, computational) and research topics (e.g. hippocampus, substance abuse). This new program will help retain GMU & VA on the cutting edge of scientific research and education, and will aim at a position of world leadership in selected areas of neuroscience.
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1. Introduction – Neuroscience at GMU

Over the past decade, a variety of somewhat fortuitous developments have led to a nascent potential in the field of neuroscience at George Mason University. These include a conference in 1993 on “The Mind, the Brain and Complex Systems”, co-sponsored with the Santa Fe Institute; the construction of the Krasnow Institute Laboratory Facility, which was dedicated in 1997; and the recruitment of Nobel laureate Vernon Smith’s team from University of Arizona. The 1993 Conference included two Nobel laureates as presenters (Herb Simon and Murray Gell-Man) and a number of other distinguished academics including John Holland, Daniel Dennet and the late Patricia Goldman-Rakic. It resulted both in a published volume (H. Morowitz and J.L. Singer, eds. “The Mind, the Brain and Complex Adaptive Systems”, Reading, MA: Addison-Wesley, 1995) and in a scientific focus for the nascent Krasnow Institute, which had been recently brought to the University as a result of a substantial bequest.

Beginning in May of 1997, the 23,000 square foot Krasnow Institute Laboratory facility added substantial dedicated research space to square footage already available in David King Hall. These additional resources were deployed effectively to recruit a series of talented faculty to the University, all of whom were both well-funded and neuroscientists.

By January of 2003, neuroscience at George Mason University had expanded to include 21 self-identified tenure-line faculty across various units of the College of Arts and Science, the School of Computational Science, and the Krasnow Institute for Advanced Study (see Appendix I). Adding credibility to this nascent critical mass, the 2002 Nobel Prize in Economics was awarded to Economics Professor Vernon Smith, whose group included perhaps the first neuro-economics principal investigator in the world, Dr. Kevin McCabe. Neuroscience at the University covered a broad spectrum of topics ranging from molecules to primate behavior. The productivity of key players within the GMU neuroscience community in terms of high impact publications and sponsored research has led to the perception that this area may be critical to the future growth of Mason as a research university. The local chapter of the Society for Neuroscience for the greater Washington area was moved to GMU in 1997, and a weekly public neuroscience seminar series on the Fairfax campus is now in its 9th consecutive year.

The neuroscience faculty at GMU is varied and consists of a unique blend of traditional experimental and theoretical scientists. Faculty research focuses on the broad areas of behavior, anatomy, physiology, biochemistry, computational modeling, and informatics. External research collaborations exist with federal agencies, private corporations and other universities. The scope of research ranges from the subcellular / molecular level (in the context of such phenomena as drug addiction and the biological basis of schizophrenia) to the systems / behavioral level (including cognitive studies on great apes in collaboration with the National Zoological Park). Research projects include:

- effects of drugs and alcohol on behavioral and neurological development,
- cellular organization and connections of sensory processing areas in fish,
- connection between quantum processes and brain dynamics,
- cellular and sub-cellular models of associative learning,
- biochemical dynamics in disorders of the basal ganglia,
- computational methods for simulation of complex biological systems,
role of metals in memory and Alzheimer's disease, 
description and generation of neuronal morphology, 
dynamical behavior of neurons and networks of neurons, 
adaptive control for stabilization of epilepsy, and 
biochemical/metabolic simulations at the organism level.

The Deans and Director of the College of Arts and Sciences, School of Computational Sciences, and Krasnow Institute recognized that a University-wide Ph.D. in neuroscience, which combined related concentrations within the existing programs in the respective units#, would produce a Ph.D. program much stronger than the present Ph.D. programs for students in neuroscience. A coordinated approach across academic units is advocated — one that recognizes the positive benefits of decentralized control, while at the same time promoting synergies in strengths.

The main objective of the proposed Ph.D. program in Neuroscience is to train students to be research scientists in academia, industry, and government. The program will provide students with an interdisciplinary academic environment for comprehensively developing their intellectual ability to successfully pursue a career in the neurosciences. In addition, the proposed Ph.D. program would invigorate the research environment for existing neuroscience faculty.

2. Academic Structure of the Program

2.1. General structure, course and credit requirements

Students admitted to the program are supposed to have undergraduate education in basic mathematics, physics, chemistry, and biology. The total proposed curriculum consists of 72 credit hours, half of which are lectures and seminars and the other half research based. The 72 hour total breaks down into 48 hours of coursework and 24 hours of dissertation. The 48 hours coursework requirement may be reduced by up to 30 hours for a qualified student holding a previous master’s degree. Up to 24 credit hours of previous, relevant graduate coursework may be transferred into the program provided those credits have not been applied towards a previous degree. Additional requirements for graduation include a dissertation and at least one publication (in print or in press) in a refereed journal. Students who come into the program with appropriate undergraduate background, strong and clear research motivation, and full-time commitment (>40hrs/wk for 12 months/yr) will have the possibility to earn their PhD in four years. Depending on a variety of factors, including the typically unpredictable course of thesis research, the program will be extended for most students to 5 or more years.

The course timetable below is based on 9 graduate credits plus one mandatory seminar credit per semester throughout the program, plus an additional 3 summer credits of lab rotations, directed readings, thesis proposal or thesis research every year. All of the core courses and initial “lab rotations & readings” (see below) will be taken in the first two years. At the end of the second year, students may already have their thesis proposal ready to defend as well as their initial course work (as described below) completed. These students will be able to take the Qualifying examination and defend their thesis proposal at the same time. Other students may elect to take

the two steps separately, and may take an additional year to complete the initial coursework. In any case, the Qualifying examination should be taken by the end of the third year. After the Qualifying examination, students will have a few more hours of elective courses in their area of specialty, but will mostly concentrate on their thesis research.

Two non-binding concentrations are included in the program. The first one includes faculty and courses in behavioral, anatomical, and molecular neuroscience (BAM), while the second one includes theoretical, computational, and physiological neuroscience (TCP). All students will follow almost the same curriculum for the first two years, although concentration prerequisites may vary slightly (e.g. students in the TCP concentration must have basic knowledge in integral Calculus). It is expected that selection of electives and of course thesis topic will vary widely between the two concentrations. However, students will be allowed to “mix and match” electives from both concentrations with Advisor and Graduate Coordinator guidance and permission.

2.2. Neuroscience@GMU Seminars and Rotations & Readings

Every Fall a special 1-credit “Neuroscience@GMU” seminar series will be organized for first year students. Each week, a different neuroscience laboratory and principal investigator will give two lectures to students. The first one will be an introductory lecture on the neuroscience basics necessary to appreciate the laboratory research theme and mission. The second will be a more practical description (and possibly lab visit) of the active research program of the lab, and of the open projects for both lab rotations and PhD theses. This seminar series will be useful for students to both learn about the research at the University and to select their lab rotations and eventual thesis topic.

Each semester (3 credits) of lab rotations and readings (R&R) can consist of 130hrs in one lab or 65hrs in each of two labs (with approval of both advisor and lab chief). At the end of the second year each student has to have completed R&R in at least 3 different labs. Projects can involve directed literature search and reading, data collection and/or analysis, or a mixture of any of the above, as determined by the lab chief. Rotations and Readings will be essential to broaden the base of practical neuroscience research that students are exposed to during the early stages of their graduate education. It is expected that this experience will also help students chose the laboratory for their dissertation and a thesis topic.

2.3. Curriculum and semester-by-semester coursework

First 2 years (total credits: 27 lecture + 15 research = 42)

- 9 credits core biology
- 13 credits core neuroscience
- 3 credit concentration specific
- 9 credit rotations and readings
- 6 credit dissertation proposal
- 2 credits seminar
Qualifying examination and Thesis proposal defense

Subsequent years (total credits: 30)

18 credits of thesis
12 credits of electives (neuroscience or other GMU courses as approved by Advisor and Graduate Coordinator)

Coursework: see Appendix II for catalog descriptions of existing courses and Appendix III for syllabi of new courses.

Fall 1

Krasnow Monday Seminars
NEUR 601/PSYC527 Developmental Neuroscience (2:2:0)
NEUR 602/BIOS721 Cellular Neuroscience (3:3:0)
NEUR 709 Neuroscience@GMU Seminars (1:1:0)
3 credits Concentration specific elective or Core biology * (Chemistry & the Brain (PSYC 556: Ascoli), Biochemistry (BIO 583), Cell Biology (BIO 584))

Spring 1

Krasnow Monday Seminars
NEUR 603/PSYC 531 System Neuroscience (4:3:3)
NEUR 701 Neurophysiology Laboratory (2:0:6)
NEUR 703/BIOS 703 Rotations and Readings (3:0:9)

Summer 1
NEUR 703/BIOS 703 Rotations and Readings (3:0:9)

Fall 2

Krasnow Monday Seminars
NEUR 702/BIOS703 Research Methods (3:3:0)
NEUR 703/BIOS 703 Rotations and Readings (3:0:9) or Concentration Specific Core
NEUR 611/PSYC 611 Statistics (3:3:0)

Spring 2

* Basic knowledge in Biochemistry and Cell Biology is required by the end of the first semester. Students without Organic Chemistry should take Chemistry and the Brain. Students with Organic but without Biochemistry should take Bio583. Students without upper level Biology should take Cell Biology. Students requiring background in both Biochemistry and Cell Biology shall take both courses, but only 3 credits will be counted towards the degree. Students who are already proficient in Biochemistry and Cell Biology should chose an elective in consultation with the Advisor and the Graduate Coordinator.
Krasnow Monday Seminars
Concentration specific core (3 credits) or NEUR 703/BIOS 703 Rotations and Readings

(3:0:9)
NEUR 604/CSI 639 Ethics in Scientific Research (2:2:0)
NEUR 998 Dissertation proposal (3:0:0)
NEUR 710 Special Topics in Neuroscience (1:1:0)

Summer 2

NEUR 998 Dissertation proposal (3:0:0)

Significant individual specialization in coursework and research is possible from the third year on (Table 1). For example, a student interested in modeling may take coursework in modeling at the neuronal, systems, and cognitive functioning levels, and pursue a dissertation in any of these levels. A student interested in CNS development may pursue this at the neuroanatomical, neurochemical, and behavioral levels. Students interested in neural functioning may work at the single cell, neuronal ensemble, or larger brain area level. Although work in faculty laboratories is required, students may also occasionally take advantage of the proximity of the National Institutes of Health and other nearby Federal research facilities. Finally, in addition to significant neuroscience expertise, some students may take advantage of other expertise and facilities within the other GMU doctoral programs (e.g. Bioinformatics, Biopsychology, Biosciences, SITE). The program seeks to train students rigorously in current methods and problem areas, and to graduate students prepared to develop and assimilate new techniques, methods of inquiry, and problem areas emerging in the future.

Table 1: Existing Elective Courses by Concentration (See Appendix II for Catalog Descriptions)

<table>
<thead>
<tr>
<th>Behavioral, Anatomical, and Molecular (BAM)</th>
<th>Theoretical, Computational, and Physiological (TCP)</th>
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<tr>
<td>Selected Topics in Genetics (BIOL 575)</td>
<td>Numerical Methods (CSI 700 or BINF 690)</td>
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<td>Molecular Evolution and Conservation Genetics (BIOL 579)</td>
<td>Biochemical and Cellular Models (BINF 739)</td>
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<tr>
<td>Genomics (BIOS 741)</td>
<td>Foundations of Computational Sciences (CSI 701)</td>
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<tr>
<td>Molecular Genetics (BIOS 744)</td>
<td>Computational Neurobiology (CSI 734)</td>
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<tr>
<td>Neuroeconomics (ECON 895)</td>
<td>Computational Neuroscience Systems (CSI 735)</td>
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<td>Philosophy of Psychology (PHIL 574)</td>
<td>Linear and nonlinear modeling in the natural</td>
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<td>Neuronal Bases of Learning &amp; Memory (PSYC 558)</td>
<td>sciences (CSI 744)</td>
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<td>Behavioral Chemistry (PSYC 559)</td>
<td>Introduction to Artificial Intelligence (CS 580)</td>
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<tr>
<td>Behavioral Biology of Substance Abuse (PSYC 561)</td>
<td>Natural Language Processing (CS 680)</td>
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<tr>
<td>Trends in Modern Neuroscience (PSYC 592/1)</td>
<td>Computer Vision (CS 682)</td>
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<td>Visual Neuroscience (PSYC 592/2)</td>
<td>Advanced Artificial Intelligence (CS 687)</td>
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<tr>
<td>Computational Neuroanatomy (PSYC 592/3)</td>
<td>Neural Network Principles (CS 688)</td>
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<tr>
<td>Cognitive and Perceptual Development (PSYC 666)</td>
<td>Machine Learning (CS 782)</td>
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<td>Dynamical Systems (MATH 673)</td>
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<td>Cognitive Modeling (PSYC 768)</td>
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<tr>
<td>Cognitive Neuroscience (PSYC 702)</td>
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<td>Advanced Topics in Sensation and Perception (PSYC 766)</td>
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<tr>
<td>Developmental Psychobiology (PSYC 592/4)</td>
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<td>Mental Illness &amp; Drug Abuse (PSYC 592/5)</td>
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<td>Drugs and Human Behavior (PSYC 592/6)</td>
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Table 2: Elective Courses to be Developed as the Program Grows

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<tr>
<th>Comparative Great Ape and Mammalian Cognition (NEUR 742)</th>
<th>Advanced electrophysiology (NEUR 821)</th>
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<tr>
<td>Learning Disability and Dyslexia (NEUR 743)</td>
<td>Neuroinformatics (NEUR 771)</td>
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<tr>
<td>Histochemistry (NEUR 761)</td>
<td>Computational Models of Animal Learning (NEUR 744)</td>
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<td>Second Messengers (NEUR 762)</td>
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Table 3: Proposed New Courses by Concentration (See Appendix III for Syllabi)

<table>
<thead>
<tr>
<th>Concentration</th>
<th>Behavioral, Anatomical, and Molecular (BAM)</th>
<th>Theoretical, Computational, and Physiological (TCP)</th>
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</table>
| Required Courses | NEUR 701 Neurophysiology Laboratory  
NEUR 709 Neuroscience@GMU Seminars  
NEUR 710 Special Topics in Neuroscience  
NEUR 998 Dissertation proposal  
NEUR 999 Doctoral Dissertation | NEUR 751 Applied Dynamics in Neuroscience  
NEUR 752 Modern Instrumentation in Neuroscience  
NEUR 851 Advanced Computation and Brain Dynamics |
| Elective courses | NEUR 741 Introduction to Neuroimaging | NEUR 751 Applied Dynamics in Neuroscience  
NEUR 752 Modern Instrumentation in Neuroscience  
NEUR 851 Advanced Computation and Brain Dynamics |

2.4. Qualifying examination and dissertation proposal

During the first two years in the program, each student forms a dissertation supervisory committee consisting of the Advisor plus 3 or 4 appropriately qualified individuals. At least 3 committee members, including the Advisor, must be tenure-line faculty in the SCS, CAS and/or Krasnow Departments. The committee must be approved by the Graduate Coordinator.

After completion of all core course requirements, each student must take a Qualifying Examination with the supervisory committee. The goal of the examination is not to retest knowledge of core courses, but for students to demonstrate (1) mature knowledge of topics in
their concentration, (2) the ability to synthesize information from multiple courses and from the literature, and (3) be prepared for dissertation research. The Qualifying Examination consists of two parts: a written portion and an oral portion. Both the written portion, or a part of it, and the oral portion can be retaken at most once (each). The oral portion can last up to two hours. Its purpose is to follow up on the written exam and to assure that the student can think promptly and accurately about the material studied.

Each student prepares a written dissertation proposal, which is presented to the supervisory committee. Thesis proposal must be written in the format of grant application. US citizens and permanent residents are expected to submit these proposals to NIH or NSF as appropriate. Non-residents are expected to submit these proposals to granting agencies (e.g. Human Frontiers Science Program) that fund foreigners studying in the US. The committee will assess the proposal and assist the student in fulfilling his/her responsibility to have a clear topic with the potential to make a significant contribution to the field, along with a clear methodology. The committee also will assess whether the student has the intellectual background and the resources to have a good chance of completing a successful dissertation in a timely manner. The dissertation proposal should be produced and defended within a year after completion of the Qualifying exam. This makes it possible to assure that the student has a suitable topic while there is still time to make meaningful adjustments. After successfully completing this requirement, the student is formally advanced to candidacy for the PhD degree.

2.5. Dissertation

The Ph.D. dissertation entails independent research after advancement to candidacy. The work must represent an original achievement in research and constitute a significant contribution to its field. Research should be conducted under the guidance of the Advisor and should be deemed publishable in refereed journals or refereed conference proceedings.

A dissertation manuscript must be written by the student. Published material can be included in the dissertation if the student is first and main author. Publications listing the students as middle author (or in any case if the Advisor judges the related work not to be mainly by the student) can be included in the appendix. If the student has a sufficient number of high-impact publications as first and main author, the dissertation can be assembled primarily from this material with the Advisor’s recommendation. It is understood that modern scientific research is often the fruit of collaborative efforts, and articles included in dissertation can be coauthored by the Advisor as well as other individuals. However, the supervisory committee has the final authority in deeming the contribution of the student to the whole dissertation research as sufficiently original and independent.

The student prepares to defend the dissertation in consultation with the Advisor. The date of the defense must be agreed upon by all members of the committee, and the dissertation must be made available to the committee at least two weeks before the examination date. The defense is given as a public seminar presentation of the dissertation, followed by an oral examination by the committee. If the candidate successfully defends the dissertation, the committee recommends that the final form of the dissertation be completed, and that the graduate faculty of George Mason University accept the candidate for the Ph.D. degree.
3. Administration, Admissions and Assessment

3.1. Administration

The program will be administered by the Graduate Coordinator and an executive committee. The Graduate Coordinator will be appointed jointly by the Deans of CAS and SCS and by the Director of the Krasnow Institute, will be selected among the Neuroscience faculty, and will chair the executive committee. The executive committee will be composed of two neuroscience faculty members from each of CAS, SCS and the Krasnow Institute, appointed by the Deans and Directors of their units. The tasks of the Graduate Coordinator will include the following:

- faculty coordination to ensure the regular teaching and coverage of courses
- organization of the Neuroscience@GMU seminar series
- creation and maintenance of a program web page (possibly with the assistance of University educational and technological resources)
- student advising with respect to course requirements, available concentrations, and development of individual courses of study
- establishment of dates and guidelines for comprehensive exams and thesis proposal defenses
- assignment of fellowships and tuition waivers
- administration of the admission process, including decisions on credit transfer from other institutions or programs

3.2. Admission requirements and procedures

Applications will be accepted for the Fall semester and, in limited cases, for the Spring semester for students needing additional prerequisites. The deadline for receipt of application material is February for Fall admission and October for Spring admission. Due to financial aid considerations, students are always encouraged to apply for the fall. Preparation for the Ph.D. program in neuroscience should include a Bachelor’s degree in a relevant field and undergraduate courses in chemistry and cell biology, and, for students interested in the TCP concentration, integral calculus. Students lacking background in these areas will be considered for admission, but may be required to satisfy prerequisite courses prior to the required graduate courses. The program normally requires a minimum 3.25 cumulative undergraduate GPA and acceptable GRE and TOEFL scores, but exceptions will be considered on an individual basis. Applicants who meet these minimum criteria will be considered for admittance to the program on the basis of experience, letters of recommendations, maturity in the statement of interests, and other relevant credentials. Application material includes the following:

- Completed application form
- All undergraduate and graduate transcripts
• Three letters of recommendations from faculty members or individuals who have firsthand knowledge of the applicant’s academic or professional capabilities.

• A statement of purpose consistent with the research interests of at least one faculty member in the program.

• The names of two faculty members that may be suitable as Advisors or supervisory committee members.

• Graduate Record Examination (GRE) taken within the past five years prior to the date of application submission.

• Test of English as a Foreign Language (TOEFL) as per GMU policies.

The Graduate Coordinator will review the applications and forward them to the faculty members listed in each application, and, if no one is interested, to the rest of the faculty. For a given year, actual admissions will be determined by the available funding for the program and the ability to “match” students with at least one faculty member on the basis of research interests. The matched faculty member will serve as the (initial) advisor for the student. Applicants may be required to interview. No specific set of qualifications guarantees admission to the program.

3.3. Financial assistance

Financial assistance is available at competitive levels through graduate research assistantships, graduate teaching assistantships and fellowships. Most neuroscience faculty at GMU are well supported by external grants and contracts. These funds will be used to support students after completion of the first two years of core courses. Specifically, students will be supported by the laboratory of their thesis advisor from the time they officially join the laboratory until they earn the degree. For the first two years, students will be supported by University Research Fellowships. This includes the High Potential Fellowship program of the Provosts Office, as well as graduate fellowships provided by CAS, SCS and the Krasnow Institute. Research assistantships during the first two years include $18k in salary (12-month assistantship) plus 21 credits of tuition remission (in-state or out-of-state, as applicable), and no teaching responsibilities. Teaching assistantships for third-year students who have not yet passed the Qualifying examination, or have not been “matched” by a given laboratory may be available. They guarantee the same salary and tuition benefit as the Research assistantship, but imply responsibilities corresponding to the teaching of one course for each of two semesters, or assisting faculty members (e.g. grading, partial teaching, etc.) in two courses for each of two semesters. Teaching assignments will be coordinated by the Graduate Coordinator and by the Chairs of CAS and SCS Departments. In order to qualify for Teaching assistantships, students must take the Teaching Methods (PSYC 850) course, or courses deemed equivalent by the Graduate Coordinator and by the Department Chair in which they will carry out their teaching responsibilities. We should reiterate here that students are strongly encouraged to apply for predoctoral fellowships both upon admission in the program (e.g. NSF fellowships) and upon defense of their dissertation proposal (e.g. NIH fellowships). These applications constitute by all means part of the Program training. If awarded, extramural fellowships guarantee both a higher stipend for the student and financial release for the Program and the affiliated laboratories. Most
importantly, these fellowships entail an invaluable level of prestige and recognition both for the student and the Program itself.

3.4. Planning and advising

From the application process, the students must select among the University Neuroscience faculty one or two potential Advisors and two or more potential supervisory committee members. Upon admission, the Graduate Coordinator and Neuroscience Faculty will match each student with a (temporary) advisor. Students will be given maximum flexibility to freely select their permanent Advisor during the first two or three years in the Program, in part based on how their interest develop with coursework and Rotation and Readings. Together with the Advisor and the Graduate Coordinator, the student may from the beginning form a faculty supervisory committee to help him or her establish and carry out a Plan of Study that meets the academic requirements and will properly prepare the student for the dissertation phase. This committee must be in place in any case before the Qualifying exams (see section 2.4).

3.5. Learning outcomes and student assessment plan

Graduates are expected to demonstrate the ability to carry out independent and innovative interdisciplinary scientific research in neuroscience. The graduate will have a demonstrated ability in theory, experiment, data analysis, and the performance of independent research. The core curriculum (see previous section) is designed to cover the essential knowledge base, which all students are expected to master. Participation in group projects during courses will foster the student’s ability to work as a member of an interdisciplinary team of scientists.

Upon completion of the program, each student will be expected to have achieved all of the benchmarks listed below. The achievement of these benchmarks will be determined by successful completion of coursework, the dissertation research, the dissertation defense, and the written and oral qualifying exams, as described in the previous section.

- Understand and apply core concepts in neuroscience
- Understand and apply theoretical, experimental, and laboratory concepts relevant for the specialized research area
- Pose a scientific question and conduct original research in order to answer it
- Develop written and oral communication skills appropriate to the field
- Participate effectively as a member of an interdisciplinary science team
- Abide by the values and ethics of the scientific profession

3.6. Evaluation of program effectiveness and benchmarks

Several metrics will be used to judge the new program. The major criteria will be the continued graduation of quality Ph.D. students at a rate commensurate with the historical rate of the present
programs. A second metric will be student enrollment at rates higher than the current enrollment in the neuroscience concentration of the Biosciences Ph.D. plus the computational neuroscience concentration of the Computational Sciences Ph.D.. Additionally, every five years a panel consisting of both GMU faculty and external faculty from other neuroscience programs will be assembled by the Deans of CAS and SCS and by the Director of the Krasnow Institute to review the progress of the program and comment upon areas of possible improvement. The comments of the panel will be collated and recorded to aid strategic decisions for the advancement of the program. Because the new Ph.D. program is a synthesis of existing programs, it will be considered in the best interest of the program to accelerate the first review and hold it during the second or third year of the new program.

As soon as the first students graduate from the program, GMU will be in the position to apply for an NIH institutional training grant. The award of such a grant would guarantee a larger number of more competitive fellowships, and would help the program grow both directly and freeing financial resources to be used for lab equipment and needed faculty positions.

3.7. Relationship to existing Ph.D. programs at the University

The new program was formed from the union of the neuroscience concentration in the Biosciences Ph.D. of SCS and the computational neuroscience concentration in the Computational Sciences Ph.D. of SCS. Both of these concentrations were small, and lacked the critical mass of students, faculty or coursework to attract top students in neuroscience.

The new Neuroscience program has a small overlap with the existing graduate Biopsychology program. However, there are significant differences between Biopsychology and a Neuroscience Ph.D. The Psychology degree has, understandably, a heavy emphasis on behavior. Its requirements leave little time for interested students to work in biochemistry, CNS modeling, or neuroanatomy. One of the reasons for the proposed program is that prospective students interested in working with some of our neuroscientists currently have no appropriate avenue to pursue their interests. Approval of the proposed degree would attract students who are not attracted to the current Biopsychology degree.

3.8. Collaborative efforts with other schools and institutions

This degree represents a collaborative effort between CAS, SCS, and the Krasnow Institute. Many of the faculty involved in the program have joint appointments in two of the units. In particular, one member of SCS has a Krasnow Institute appointment, several faculty in the psychology and physics departments of CAS have appointments in the Krasnow Institute. Several of the faculty in the psychology departments of CAS have appointments in SCS. Neuroscience at GMU offers synergies across a number of other disciplines and research areas in which GMU already has strength. Within the School of Information Technology and Engineering, the research areas of robotics, computer vision, evolutionary algorithms and artificial neural networks grew out of the desire to imbue computers with analytic skills possessed by human brains. The growing new discipline of neuroinformatics represents the intersection of bioinformatics, a strong program in SCS, and the proposed neuroscience program. Regarding links with other institutions, CAS and SCS faculty are involved in ongoing research.
collaborations with area government agencies (NIH, NIST, NRL, and NASA/Goddard), and large international collaborations.

4. JUSTIFICATION FOR PROPOSED Ph.D. PROGRAM

4.1. Student demand and projected enrollment

We have three indicators of significant student demand for the proposed program:

(1) Interest from students in the present SCS Ph. D. computational sciences program, with a concentration in neuroscience, who are seeking a program with more training in traditional neuroscience.

(2) Interest from students in the present biopsychology Ph.D. program, who are seeking a program with less emphasis on behavior, and more time to study cellular neuroscience, biochemistry, or neuroanatomy.

(3) Inquiries from students who want to work with our neuroscience faculty, but are not attracted to any of the existing GMU programs with neuroscience concentrations.

(4) The graduates in years 2, 3, and 4 represent students who are already enrolled at GMU in other degree programs, who are expected to switch to the Neuroscience Ph.D. program when it becomes available. Several of these students have nearly completed the coursework requirements for the new degree, and therefore they should be able to graduate from the Neuroscience program within 2-4 years of program inception.

Projected enrollment:

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Target Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>GRADS</td>
<td>GRADS</td>
<td>GRADS</td>
<td>GRADS</td>
<td>GRADS</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>HDCT</td>
<td>FTES</td>
<td>HDCT</td>
<td>FTES</td>
<td>HDCT</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>8</td>
<td>6</td>
<td>11</td>
</tr>
</tbody>
</table>

Definitions: HDCT—fall headcount enrollment, FTES—annual full-time equated student enrollment, GRADS—annual number of graduates of the proposed program
4.2. Employment demand for graduates

Neuroscience constitutes one of the fastest growing and most popular branches of science. With 32,000 members, the Society for Neuroscience is the World’s largest professional scientific organization.

The Bureau of Labor and Statistics (BLS) projects a faster-than-average job growth for biological and medical scientists through the year 2010. On the other hand, competition for jobs and grants in biological and medical science is expected to increase, because the number of newly trained scientists continues to grow faster than the funding by the Federal government.

When specialties such as neuroscience are considered separately, the prospects are much better. Neuroscience is an area of research that is likely to be well-funded for the foreseeable future. The examples of Christopher Reaves, Michael J. Fox and Tipper Gore underscore the ability of research success in the neuroscience arena to generate both media attention and dollars. As the baby-boom generation ages, degenerative brain disorders such as Alzheimer's and Parkinson's will afflict a greater number of individuals in the population. Concomitantly there are a host of psychiatric conditions (e.g. schizophrenia) for which the etiology is still unknown. Multi-disciplinary approaches in these and other areas of neuroscience are not only clinically relevant, but also timely as reductionist molecular approaches have been hitherto unsuccessful in cracking the mechanisms of neural function.

Similar to the funding situation, the BLS predicts employment growth in health areas such as Alzheimer's disease. Within the National Institutes of Health, neuroscience research accounts for more than 20% of total projected biomedical expenditures in FY04 (www.aaas.org/spp/rd/nih04p.pdf). Over half of the NIH grants to GMU in 2003 are in the neurosciences (http://crisp.cit.nih.gov/). Hence, the market for interdisciplinary neuroscientists is strong and will remain strong over the next decades. Future neuroscientists can expect to find positions in academia, pharmaceutical companies, biotech and government labs in jobs that range from development of drugs to development of defibrillators that alleviate Parkinson’s Disease tremors.

On the one hand, the Commonwealth of Virginia has a significant interest in increasing the number of skilled workers in neuroscience. On the other hand, there is a significant student demand and market need in this field.

4.3. Comparison with other programs in region and state

We are aware of several other interdisciplinary neuroscience Ph.D.s in Virginia and the region. For example, the University of Virginian offers an interdepartmental neuroscience Ph.D.. This is a joint program administered by the College of Arts and Sciences and the School of Medicine. Disciplines of study include cell biology, biochemistry, pharmacology and physiology.
Georgetown University Medical Center offers an interdisciplinary neuroscience Ph.D. Faculty research interests are in the area of cellular and molecular neurobiology, development and regeneration, cognitive neuroscience and disorders of the nervous system. George Washington University has an interdisciplinary program through the Columbian School of Arts and Sciences and the School of Medicine and Health Sciences. Research areas include development, molecular mechanisms of drug abuse, neural transplants, neurotransmitter systems, and learning and memory.

Most of these programs have a significant focus on clinical neuroscience and the neurobiology of disease, with a small component related to behavior. In addition, the emphasis is on molecular neuroscience, with much less interest in systems level neuroscience. In contrast, the proposed neuroscience Ph.D. at GMU has a strong emphasis on both behavioral neuroscience and systems level neuroscience. Furthermore, the proposed program is unique in having a separate concentration for theoretical, computational and physiological neuroscience. In other words, the emphasis on mathematical and computational approaches to understanding the brain distinguishes the proposed neuroscience Ph.D. from other programs in Virginia and the Washington DC metropolitan area.

4.4. Benefit to GMU as a whole

Institutional growth and establishment in the field of integrative or systems neuroscience has the potential to catalyze the transformation of GMU into a research university powerhouse. Growing neuroscience at GMU offers synergies across a number of other disciplines in which GMU already has strength. These include robotics, computer sciences, bioinformatics and bio-psychology. Building in neuroscience will facilitate the University’s private sector fundraising efforts in a way that few other fields of basic research can. Neuroscience is an area of research that is likely to be well-funded for the foreseeable future, and includes significant private foundations. Shared facilities such as animal care, high performance computing and brain imaging strengthen the University as a whole and consequently leverage investments in neuroscience.

5. Available and Additional Resources

Since this PhD program in neuroscience is created from two related concentrations of existing doctoral programs at GMU, only minimal additional resources are required. The main ones regard student financial support, which is severely lacking in the present programs, and one faculty hire to fill an important gap and ensure complete coverage of all fundamental neuroscience topics.

5.1. Student fellowships

The single most important factor that will determine the success of the program is the level of financial support guaranteed to students upon admission. Though we expect that some students may attend on a part time basis (as is seen in the computational neuroscience concentration of the SCS doctoral program), we anticipate that most students will attend on a full-time basis (as seen
in the biosciences doctoral program). We have carefully assessed available research and teaching assistant positions, current grants, and stipends offered by competitive programs. For example, George Washington University, a peer institution both in terms of geographical location and targeted students, is offering Neuroscience PhD students guaranteed salary support for the first three years at a level of $22k/yr. Thus, we believe that the fellowship structure we propose (see section 3.4.) is a modest minimum without which program sustainability is not realistic.

Grants are not an appropriate funding source for first- and second-year students. Grants require large amounts of time in a single laboratory, and students in the first years of the program will be primarily engaged in coursework and laboratory rotations. Furthermore, the top programs in biomedical research typically support the PhD students off central support for the first two years. After this they are to be supported off research grants, pre-doctoral fellowships, and/or internal GTA positions. Thus, the program needs the University to guarantee to all admitted students two years of competitive, 12-month research fellowship ($18k/yr plus 21 credits/yr of full tuition waiver), plus an optional 3rd year of TA with same salary.

Resources available to the program include one high potential graduate research fellowship per year from the provosts office, and several graduate research and teaching fellowships provided by SCS, CAS and Krasnow. In addition, most of the neuroscience faculty are well funded, and have the resources to support the projected student enrollment during the third and subsequent years, though a tuition waiver will be required for students supported on research grants. In addition to these internal and external resources, all students will be strongly encouraged to submit proposals to appropriate sources for pre-doctoral fellowship support.

5.2. Faculty

The program can count on almost 30 faculty (see Appendix I) from 6 academic units (Psychology, Physics, Biology, Mathematics, Krasnow Institute, Graduate School of Education) who will be associated with the proposed program, both teaching courses, and mentoring and advising students. A key feature of current faculty is that most of them bridge multiple aspects of CNS research, as illustrated by three examples (all of which are supported by significant extramural funding): A group headed by Steven Schiff is examining the function of multi-unit ‘ensembles’ of neurons. This is a level of analysis overlooked by most extant research in neuroscience, which focuses on single neurons, or very large brain areas. Schiff’s group is using electrophysiological techniques to study and control neural activity, plus mathematical models to understand their activity. They are also developing applications (one already patented) to use this information to control epileptic activity in human brain. A second example is work on developmental drug effects, headed by Smith. This work includes individual research on behavioral effects of drugs, collaborative work on immune consequences of developmental drugs (with Coss), and incipient work on gene expression changes induced by developmental drugs (with Chandhoke, Fryxell, and others). A third example is the work of Ascoli, which is part of the federated Human Brain Project. Ascoli has worked both in the biochemistry of neural functioning, and in modeling of effects of neural structure upon neural functioning. Current research includes experimental reconstructions of neuronal morphology with optical and confocal microscopy, and computational modeling at the cellular and network level.
Thus, most faculty work in an atmosphere of flexible, self-assembling collaboration. Administrative boundaries are no impediment to such collaboration at Mason, and the result has been a group of faculty who work well together, in various ways and on various issues. The organization of the program that we propose, in two concentrations, exclusively serves the purpose of clarity in the number and breadth of educational and research opportunity that are offered to the students.

Table 4. Faculty by Concentration (See Appendix I for Area of Specialty):

<table>
<thead>
<tr>
<th>Behavioral, Anatomical, &amp; Molecular (BAM)</th>
<th>Theoretical, Computational, &amp; Physiological (TCP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sue Bachus</td>
<td>Giorgio Ascoli</td>
</tr>
<tr>
<td>Geoff Birchard</td>
<td>Ernie Barreto</td>
</tr>
<tr>
<td>Ann Butler</td>
<td>Avrama Blackwell</td>
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<tr>
<td>Vikas Chandhoke</td>
<td>Ken DeJong</td>
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<tr>
<td>Linda Chrosniak</td>
<td>Bruce Gluckman</td>
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<tr>
<td>Marcia Coss</td>
<td>John Guillory</td>
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<td>Paul Fedio</td>
<td>Saleet Jafri</td>
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<td>Jane Flinn</td>
<td>Menas Kafatos</td>
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<td>Karl Fryxell</td>
<td>Chris Kello</td>
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<td>Barbara Given</td>
<td>Tim Sauer</td>
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<tr>
<td>Layne Kalbfleish</td>
<td>Steve Schiff</td>
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<td>Kevin McCabe</td>
<td>Paul So</td>
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<td>Jim Olds</td>
<td>Jeff Tollaksen</td>
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<tr>
<td>Robert Smith</td>
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<tr>
<td>Jim Willett</td>
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</table>

The program needs a tenure line electrophysiologist who would teach (a) core neurophysiology lab (see example syllabus in appendix III) and (b) advanced electrophysiology elective (detailed syllabus to be developed by the new hire). This new faculty is needed because a neuroscience program without a physiology laboratory is not feasible. Much basic neuroscience focuses on the electrical activity of neurons and glia, and students must have practical exposure to the most fundamental concepts and techniques in order to be ready to play a leading role in modern neuroscience research. There is currently no one among the GMU neuroscience faculty who can fill this gap. In the current neuroscience market, considerable start-up costs for equipment, one postdoctoral fellowship, and a suitable space for both office and lab, are necessary together with a competitive salary to attract candidates with potential for future extramural funding to this position. The neurophysiology lab course also requires lab space and equipment. In the face of present financial hardship, we believe that the same equipment can be used for research and teaching purposes for the first three years of the program. Resources for this new faculty are being provided jointly by SCS and Krasnow.

Another very important position covers the histochemistry laboratory and techniques. To this extent, we propose to establish a restricted full-time faculty position with both research and teaching responsibilities. As the program grows, this position will be converted to tenure-line, and the restricted opening can then be used to fill the next needed position.
5.3. Part time personnel and course buy-downs

Many of the proposed courses would be taught by CAS faculty who presently have full teaching loads in their home department (e.g. Physics and Psychology). Although Neuroscience courses will be extensively cross-listed with other graduate programs in the University (e.g. doctoral programs in Psychology and Bioinformatics), it is likely that these courses will not reach an enrollment that is regarded by many department as the threshold value to keep a course open. At GMU, part-time faculty slots are used to compensate academic units for use of faculty time. For example, when a Physics faculty member teaches a course in the proposed program, Physics would be given one part-time slot to staff the course otherwise taught by that person. The program has been developed to maximize overlap with courses already taught by other units, and to minimize dedicated course scheduling. Nevertheless, we will still require several courses annually taught primarily or exclusively to neuroscience students.

Given the small initial size of this program, no dedicated support staff is required. All administrative duties will be carried out by a faculty member designated as Graduate Coordinator (see section 3.1). This individual will be compensated for the effort with a one course buy down per year in his/her home department.

5.4. Other resources

No classified positions, telecommunication equipment, or other lab or office space/resources are needed aside from those mentioned in section 4.2. Only exception is constituted by journal subscriptions. While some other programs (e.g., Biology) order journals which neuroscientists can use, we consider it important for the program to have its own journal budget. Increasingly, online resources are providing a source of information previously available only in hard copy journals, an option that the library will be encouraged to pursue due to the distributed nature of the GMU campuses. Finally, advertising costs for attracting students applications will be needed for the first and subsequent years of the program.
Projected Resource Needs for Proposed Program

**Part A: Answer the following questions about general budget information.**

Has or will the institution submit an addendum budget request to cover one-time costs? Yes_____ No__X__

Has or will the institution submit an addendum budget request to cover operating costs? Yes_____ No__X__

Will there be any operating budget requests for this program that would exceed normal operating budget guidelines (for example, unusual faculty mix, faculty salaries, or resources)? Yes_____ No__X__

Will each type of space for the proposed program be within projected guidelines? Yes__X__ No____

Will a capital outlay request in support of this program be forthcoming? Yes_____ No__X__
### Part B: Fill in the number of FTE positions needed for the program.

<table>
<thead>
<tr>
<th></th>
<th>Program initiation year 2004 - 2005</th>
<th>Total expected by target enrollment year 2008 - 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>On-going and reallocated</td>
<td>Added (New)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>On-going and reallocated</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Added (New)</td>
</tr>
<tr>
<td>Full-time faculty</td>
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<td></td>
</tr>
<tr>
<td>Part-time faculty</td>
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<tr>
<td>Graduate Assistants</td>
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<tr>
<td>Classified Positions</td>
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<tr>
<td><strong>TOTAL</strong></td>
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### Part C: Estimated $ resources to initiate and operate the program.

<table>
<thead>
<tr>
<th></th>
<th>Program initiation year 2004 - 2005</th>
<th>Total expected by target enrollment year 2008 - 2009</th>
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<tr>
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<td></td>
<td></td>
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<tr>
<td>Full-time faculty</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part-time faculty</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Graduate assistants</td>
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<td></td>
</tr>
<tr>
<td>Classified positions</td>
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<td></td>
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<tr>
<td>Fringe benefits</td>
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<td>Total personnel costs</td>
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<td>Targeted financial aid</td>
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<td>Equipment</td>
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<td>Library</td>
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<tr>
<td>Telecommunication costs</td>
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<tr>
<td>Other resource needs (specify)</td>
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<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Part D: Certification Statement(s)

The institution will require additional state funding to initiate and sustain this program.

____ Yes ______________________________________________
Signature of Chief Academic Officer

____ No ______________________________________________
Signature of Chief Academic Officer

If “no,” please complete Items 1, 2, and 3 below.

1. Estimated $$ and funding source to initiate and operate the program.

<table>
<thead>
<tr>
<th>Funding Source</th>
<th>Program initiation year 2004 - 2005</th>
<th>Target enrollment year 2008 - 2009</th>
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</thead>
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<tr>
<td>Reallocation within the department or school</td>
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<td>0</td>
</tr>
<tr>
<td><em>(Note below the impact this will have within the school or department.)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reallocation within the institution</td>
<td>0</td>
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</tr>
<tr>
<td><em>(Note below the impact this will have within the school or department.)</em></td>
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<td></td>
</tr>
<tr>
<td>Other funding sources</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><em>(Please specify and note if these are currently available or anticipated.)</em></td>
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</tbody>
</table>

2. Statement of Impact/Other Funding Sources.

________________________________________________________________________________________
________________________________________________________________________________________
________________________________________________________________________________________
________________________________________________________________________________________
________________________________________________________________________________________

If resources are reallocated from another unit to support this proposal, the institution will not subsequently request additional state funding to restore those resources for their original purpose.

____ Agree ______________________________________________
Signature of Chief Academic Officer

____ Disagree ______________________________________________
Signature of Chief Academic Officer

23
6. Concluding Remarks

The objective of this program is to provide Virginia, and the nation as a whole, with world-class resources for attacking the interdisciplinary research problems that characterize the challenge of understanding physiological and pathological brain processes. With nearly 50 million individuals in the United States affected by brain injury and brain disorders such as Alzheimer's, Huntington's, stroke, epilepsy, and AIDS-related neuropathologies, there is an increasing demand for understanding the function of the brain and for finding solutions to neurologic illnesses. The inclusion of experimental, computational, and theoretical science components in this program results in a unique community of scholars ideally suited for modern neuroscience research and education at the highest level.

Expeditious delivery of the program will be facilitated because a significant aggregation of faculty talent, funded research, laboratories and coursework in the two concentrations already exists within CAS, SCS, and Krasnow. On-campus resources are enhanced by the proximity to major Federal and Corporate research facilities, which may be a source both of potential students and of additional adjunct faculty. While some additional resources, especially to attract first-rate students, are required to create a Neuroscience program, the cost relative to that of creating a program at any other university is relatively slight.

The proposed Ph.D. in Biosciences will provide a platform for strengthening research and academic activities in sciences both within CAS and SCS. The architecture of this program, which is based on an interdisciplinary multi-concentration platform, will allow all participating units to collectively harness the full potential of emerging domains in neuroscience. The program acknowledges and addresses the complexity of the discipline by approaching both academic and research training at the systems level in an integrated manner. Overall the Neuroscience program will:

- Better use the expertise of existing CAS, SCS, Krasnow, and Mason faculty
- Attract outstanding students and additional grants
- Enrich existing and proposed programs
- Establish and enhance a significant strength of science program at Mason
Appendix I. List of Participating Faculty Members

Giorgio Ascoli (Computational Neuroanatomy, Neuroinformatics)
Sue Bachus (Histochemistry, Mental Illness)
Ernie Barreto (Theoretical Neuroscience)
Geoff Birchard (Developmental Biology)
Avrama Blackwell (Computational Neurobiology, Neurophysiology)
Ann Butler (Neuroanatomy)
Vikas Chandhoke (Molecular Biology)
Linda Chrosniak (Cognitive Neuroscience)
Marcia Coss (Immunology)
Ken DeJong (Evolutionary Computation, Artificial Intelligence)
Paul Fedio (Clinical Neuropsychology)
Jane Flinn (Learning and Memory, Biopsychology)
Karl Fryxell (Genomics)
Barbara Given (Learning Disabilities)
Bruce Gluckman (Neurophysics, Bioengineering)
John Guillory (Brain Processes, Quantum Physics)
Saleet Jafri (Computational Biology)
Menas Kafatos (Quantum Theory, Consciousness)
Layne Kalbfleish (Neuroimaging)
Chris Kello (Cognitive Models, Neural Networks)
Kevin McCabe (Neuroeconomics)
Jim Olds (Hippocampus, Neuronal Signaling)
Tim Sauer (Dynamical Systems)
Steve Schiff (Epilepsy, Neural Dynamics, Neurosurgery)
Bob Smith (Behavioral Neuroscience, Substance Abuse)
Paul So (Complex Dynamical Systems)
Jeff Tollaksen (Quantum Theory, Quantum Computing)
Jim Willett (Biochemistry)
Appendix II. Catalog Descriptions of Existing Courses

Numerical Methods for Bioinformatics (BINF 690, 3:3:0) Computational techniques for solving scientific problems focusing on applications in bioinformatics and computational biology. The student will develop the ability to convert a quantitative problem into computer programs to solve the problem. Efficiency and readability of code will be emphasized.

Biochemical and Cellular Systems Modeling (BINF 739, 3:3:0) The student will learn concepts and techniques that will enable them study cellular and subcellular processes using computational and mathematical methods. They will learn to describe a cellular or subcellular process by mathematical equations and analysis this system using mathematical and computational methods in order to get insight into cellular function in normal and diseased organisms.

Selected Topics in Genetics: Cancer Biology (BIOL 575, 3:3:0) In this Cancer Biology course we will discuss cancer from a genomics point of view. We will talk about tumors as an aggregate of cells with unstable genomes that propagate under strong Darwinian pressure. This course will also cover a wide range of subjects related to cancer biology: general descriptions of tumor phenomenon, overview of medical strategies to treat tumors as well as tumor strategies to escape this treatment, modern methodologies for discovery of tumor-related genes, and mostly, descriptions of the molecular pathways involved in cancer development including apoptosis.

Molecular Evolution and Conservation Genetics (BIOL 579, 3:3:0) The evolution of genes and gene families at the molecular level, including gene duplication and divergence, positive and negative selection, genetic drift, and molecular clocks. Also includes selected applications in conservation genetics, such as molecular phylogenetics and estimates of population size.

Research Methods (BIOS 702/NEUR 702, 3:0:0). This course aims at training students in research methodologies, techniques and data analysis in life sciences. The course is divided into three modules which introduce separate but equally significant components of any research project. The first module will focus on parameters required to outlining and synthesizing a problem. The second module will cover various techniques of measurement and analysis used by life scientists. Last module will cover various approaches used for data analysis and interpretations.

Rotation and Readings (BIOS 703/NEUR 703, 1:0:4). Intensive introduction to a research laboratory in the biosciences. The student will read background material pertinent to the problem under study, learn and practice research methods of the laboratory, and formulate a short final project, which may be a proposal or an actual project, demonstrating some mastery of the techniques and approaches employed.

Cellular Neuroscience (BIOS 721/NEUR 602, 3:3:0). A detailed overview of the functioning and interactions of the cellular elements of the central nervous system. Topics include structure/function relationships, the chemical/physical/electrical basis of neural signaling, local
vs. long-distance signaling, functional consequences of variations in the ‘typical’ action potential, and essentials of synaptic conduction.

**Genomics (BIOS 741, 3:3:0)** Genetic structure and function at the whole genome level. Includes some sequence analysis, comparative genomics, classical genetics, and developmental genetics, as well as analysis of synteny groups, isochores, gene families, genetic complexity, the C value paradox, directed discovery of gene functions, and animal models of human disease. Readings are taken both from recent texts and from the primary research literature. Students are expected to present one or two oral presentations of primary research papers, as well as completing midterm and final examinations.

**Molecular Genetics. (BIOS 744, 3:3:0)** Students are expected to develop an understanding of the principles of modern molecular genetics and methods of investigation of genomes of pro- and eukaryotes. This will include the understanding of the types of genetic manipulations which are carried out in research laboratories today.

**Introduction to Artificial Intelligence (CS 580 3:3:0).** Principles and methods for knowledge representation, reasoning, learning, problem solving, planning, heuristic search, and natural language processing and their application to building intelligent systems in a variety of domains. LISP, PROLOG, or an expert system programming language is used.

**Natural Language Processing (CS 680, 3:3:0).** Explores the principles of the design of computer programs that respond appropriately to questions, commands, and statements expressed in human language, particularly English. Role of knowledge representation and linguistic theory. Students become familiar with current literature to implement a limited natural language processor.

**Computer Vision (CS 682, 3:3:0).** Study of computational models of visual perception and their implementation on computer systems. Topics include early visual processing, edge detection, segmentation, intrinsic images, image modeling, representation of visual knowledge, and image understanding.

**Advanced Artificial Intelligence (CS 687, 3:3:0).** Exploration of foundational issues of artificial intelligence, such as the roles of knowledge and search, the formalization of knowledge and inference, and symbolic versus emergent approaches to intelligence. Advanced programming techniques for artificial intelligence and their relationship both to the foundational issues and to the most important application areas for artificial intelligence are studied. Major programming project required.

**Neural Network Principles (CS 688, 3:3:0).** Study of neural network models, algorithms, and applications. Several connectionist and biologically based models are introduced, and their capabilities and limitations are discussed. Varieties of application areas are presented. Network simulation project is required.

**Machine Learning (CS 782, 3:3:0).** Survey of the field of machine learning that is concerned with developing intelligent adaptive systems that are able to improve through learning from input
data or from their own problem-solving experience. Topics provide broad coverage of past and current developments in machine learning, including basic learning strategies and multistrategy learning.

**Numerical Methods (CSI 700, 3:3:0)** This course will cover the fundamental concepts of numerical methods for scientific computing. Students will learn how computational methods are constructed, and how they are used to solve problems arising from the sciences and engineering.

**Ethics in Scientific Research (CSI 639/NEUR 604, 3:3:0)** An examination of ethical issues in scientific research. The course begins with a reflection on the purpose of scientific research and a review of the foundational principles used for evaluating ethical issues. It provides skills for survival in scientific research through training in moral reasoning, and teaching of responsible conduct. Students learn to apply critical thinking skills to the design, execution and analysis of experiments and to the analysis of current ethical issues in research. Such issues include the use of animals and humans in research, ethical standards in the computer community, and research fraud. In addition, currently accepted guidelines for behavior in areas such as data ownership, manuscript preparation, and conduct of persons in authority may be presented and discussed in terms of relevant ethical issues.

**Foundations of Computational Science (CSI 701, 3:3:0).** Covers the mapping of mathematical models to computer software, including all aspects of the development of scientific software, such as architecture, data structures, advanced numerical algorithms, languages, documentation, optimization, validation, verification, and software reuse. Examples in bioinformatics, computational biology, computational physics, and global change demonstrate scientific advances enabled by computation. Class projects involve working in teams to develop software that implements mathematical models, using the software to address important scientific questions, and conducting computational experiments with it.

**Computational Neurobiology (CSI 734, 3:3:0).** An intensive introduction to systems neuroscience. The anatomy, physiology, and function of each of the major brain structures and systems will be presented. The emphasis will be on behaviors that emerges from integrated actions of populations of neurons. Computational techniques used to study and understand networks of neurons also will be addressed. Students are expected to do assigned readings prior to class and to participate in class discussions (20% of grade) and present a project in class (80% of grade).

**Computational Neuroscience Systems (CSI 735, 3:3:0).** Overview of the nervous system and biological neural networks. Topics include learning and memory, sensory systems, and motor systems. Design and application of computational models will be stressed. Students will be required to propose and design a computational model that addresses some open issue in neuroscience.

**Linear and Nonlinear Modeling in the Natural Sciences (CSI 744, 3:3:0).** Develops the tools of mathematical modeling while carrying out numerical simulations of the models. Examples from across the sciences are considered throughout the course. Topics include basic issues (models, simplification, linearity, and nonlinearity), dimensionless parameters, dimensional
analysis, models involving differential equations, examples from population growth and chemical kinetics, models involving partial differential equations, diffusion, transport, nonlinearity and shocks, probabilistic modeling, perturbation methods, extrapolation, and an introduction to stability.

**Dynamical Systems (MATH 673, 3:3:0)** Dynamical systems are the mathematical framework for studying many evolution phenomena in the applied sciences. These might be seemingly simple equations describing the size of a fish population in a pond, or systems aimed at understanding complex phenomena such as the weather. Common to most of these systems is their tendency to exhibit complex, or even chaotic behavior, due to the underlying nonlinear nature of the dynamics. In this course I plan to present the basic techniques and methods used for describing and analyzing such systems.

**Current Issues in Philosophy of Psychology (PHIL 574, 3:3:0).** Careful examination of some issue or issues of current interest to both philosophers and psychologists. Typical issues examined include the mind-body problem, philosophical and psychological implications of work in artificial intelligence, and philosophical issues in psycholinguistics.

**Developmental Neurobiology (PSYC 527/NEUR 601, 2:2:0).** A detailed summary of the current knowledge of development of the mammalian central nervous system. Topics will include genetic determinants of expression, growth processes and stages of growth of individual neurons, chemical and tactile trophic cues, controls over patterning of CNS growth, formation and maintenance of connections, molecular controls for elaboration of cell processes, activity-dependent growth and connectivity, the role of regressive events such as cell death, hormonal influences on development, developmental plasticity, actions and mechanisms of CNS mutagens, developmental anomalies underlying pathological states, and the aging brain. Students must develop a strong knowledge of current literature.

**Mammalian Neurobiology (PSYC 531 /NEUR 603,4:3:3)** Functional anatomy of the brains of mammals, with emphasis on regional and systems neuroanatomy of humans. Anatomy is correlated with material from clinical neurology where possible. Laboratory component includes brain dissections and clinical correlations.

**Neuronal Bases of Learning & Memory (PSYC 558) (3:3:0).** Examination of neuronal mechanisms involved in learning and memory, in animals ranging from invertebrates to humans.

**Behavioral Chemistry (PSYC 559, 3:3:0).** Neurochemistry and neuroendocrinology, including neurotransmitter synthesis, genetic aspects of neural functioning, mechanisms of action of neurotransmitters and second messenger systems, regulation of neuroendocrine systems, neuroendocrine effects on behavior, and neuroimmunology.

**Behavioral Biology of Substance Abuse (PSYC 561, 3:3:0).** Overview of the biological effects of substance abuse and the biological mechanisms underlying addiction. Topics include alcohol, cocaine, marijuana, and other drugs; genetics of addiction; and neural systems underlying addiction and withdrawal.
Special Topics (PSYC 592, 3:3:0). Special topics reflecting interests in specialized areas. Topic announced in advance.

Statistics (PSYC 611, 4:3:2). Integrates basic psychological statistics with an overview of research methodology (including experimental, quasi-experimental, field approaches, and measurement issues) from an advanced perspective. Lab work includes the use of computer packages for data handling and analyses.


Biological Bases of Behavior (PSYC 702, 3:3:0). Survey of physiological bases of behavior, including such topics as neural conduction and the role of specific neurotransmitters.

Advanced Topics in Sensation and Perception (PSYC 766, 3:3:0). Emphasizes current research in sensation and perception. May be repeated for credit.

Cognitive Modeling (PSYC 768, 3:3:0). Emphasizes current research in cognitive science. Topics may include computational cognitive models, the nature of expertise, diagrammatic reasoning, display-based problem solving, visual attention, decision making, goal-based versus event-based cognition, and situated action. May be repeated for credit.
Appendix III. Syllabi of Proposed New Courses

Course Name and Number: NEUR 701 (2:0:6) Neurophysiology Laboratory

Catalog Description
Hands on training in current techniques of modern neurophysiology. The course (1) acquaints the student with the theoretical basis of each technique, (2) trains the student in the laboratory skills necessary to perform each technique. Includes both intracellular and extracellular recording techniques. Preparations include both vertebrates and invertebrates. Meets once weekly for 6 hours. Prerequisites: Cellular Neuroscience. Open to candidates in the neuroscience Ph.D. program.

Tentative Syllabus

Week 1: Introduction, Lab safety, Use and care of animals in research, Use of electrophysiology Equipment, Dissection techniques

Week 2: Backfilling of nerves for morphological analysis using Vaseline wells

Week 3: Recording from ventral nerve cord of crayfish using Vaseline gap

Week 4: Recording from ventral nerve cord of crayfish using suction electrodes

Week 5: Electrical circuit exercises

Week 6: Sharp electrode recording I: Introduction to Aplysia: dissection and sharp intracellular pipettes

Week 7: Sharp electrode recording II: Intracellular recording from Aplysia abdominal Ganglia

Week 8: Sharp electrode recording III: Continuation of intracellular recording from Aplysia abdominal Ganglia, stimulation protocols

Week 9: Introduction to hippocampal slice, extracellular field potentials

Week 11: Patch pipette recording I: Introduction to patch pipettes and techniques

Week 12: Patch pipette recording II: Whole cell patch clamp of hippocampal slice

Week 13: Patch pipette recording III: Continuation of whole cell patch clamp of hippocampal slice, Input/output properties of neurons

Week 14: Analysis of in vivo data: spike sorting
Course Name and Number: NEUR 709 Neuroscience@GMU Seminars (1:1:0)

Catalog Description: Special seminar series for first year neuroscience Ph.D. students. The purpose of this seminar series is for students to both learn about the research at the University and to select their lab rotations and eventual thesis topic. Each week, a different neuroscience laboratory and principal investigator gives two lectures to students. The first one is an introductory lecture on the neuroscience basics necessary to appreciate the laboratory research theme and mission. The second is a more practical description (and possibly lab visit) of the active research program of the lab, and of the open projects for both lab rotations and PhD theses.

Tentative Syllabus

Week 1: Stephen Schiff - Epilepsy, Neural Dynamics, Neurosurgery

Week 2: Giorgio Ascoli - Computational Neuroanatomy and Neuroinformatics

Week 3: Robert Smith - Behavioral Neuroscience, Substance Abuse

Week 4: Kim Blackwell – Second Messenger Pathways in Neurons

Week 5: Paul So - Complex Dynamical Systems

Week 6: Ann Butler – Comparative Neuroanatomy

Week 7: Bruce Gluckman - Neurophysics, Bioengineering

Week 8: Jane Flinn – Learning and Memory

Week 9: Barbara Given - Learning Disabilities

Week 10: Menas Kefatos- Quantum Theory, Consciousness

Week 11: Jim Olds - Hippocampus, Neuronal Signaling

Week 12: Layne Kalbfleish - Neuroimaging

Week 13: Linda Chrosniak - Cognitive Neuroscience

Week 14: Kevin McCabe - Neuroeconomics
Course Name and Number: NEUR 710 (1:1:0) Special Topics in Neuroscience

Catalog Description: This seminar examines a number of topics in the neurosciences including neurogenetics, neural imaging, and the competing computational and biological approaches to the mind.

Proposed Course Content:

Week 1-3: Different aspects of neurogenetics - genotype, phenotype, behavioral and cognitive

Week 4-5: Different aspects of neural imaging - multi-channel EEG, fMRI, PET, MEG

Week 6: Introduction to the main ontological theories of mind; the mind-body problem and reductionism; qualia; inverted spectrum argument; Searle's Chinese room argument; Computational versus biological approaches to the mind: "can machines think?"; "is thinking symbol crunching?" (Kim, chap. 2) "Mind as the Brain: The Mind-Brain Identity Thesis"; Searle, "Is the Brain a Digital Computer")

Week 7: Computational versus biological approaches to the mind: neural nets; mental imagery; the Turing test and Deep Blue (Turing "Computing Machinery and Intelligence", Block "The Mind as the Software of the Brain", Kim "Mind as Behavior: Behaviorism"); mental representation vs. connectionism; functionalism (Kim, chap. 4 "Mind as a Computer: Machine Functionalism", chap. 5 "Mind as a Causal Structure", McLaughlin "Connectionism", Churchland "Cognitive Activity in Artificial Neural Networks")

Week 8: Concepts of Consciousness: philosophy of psychology, questions addressed include "what establishes personality or personal identity" (Kim, chap. 7 "Consciousness"); Consciousness: empirical distinctions between functionalism and physicalism (Hurley and Noe, "Neural plasticity and consciousness", Block "Spatial Perception via Tactile Sensation"); eliminativism (Dennet, "Time and the observer")

Week 9: Search for the neural correlate of consciousness (Crick and Koch; Llinas; Dennet; Block); Sensory-motor accounts of consciousness; Block's "The harder problem of consciousness"

Week 10: higher order monitoring (introspection and self-awareness); kinds of consciousness (Chalmers); phenomenal concepts (Jackson, "What Mary Didn't Know"); modal arguments for dualism; property dualism

Week 11: Is physicalism sufficient (Chalmers)?; representationism (i.e. The phenomenal character of an experience is its representational content) (Kim, chap. 8 "Mental Content", Dennet "Mind Writing and Brain Reading", Chalmers "The Representational Character of Experience")

Week 12: Functional Role Semantics: Mental and Semantic Holism holds that the meaning of a sentence that expresses a belief is constructed from it's comparison to a web of beliefs. In this
portion of the course we will explore the motivations for holism (e.g. Quine 1953, Block) and explore issues concerning the distinction between analytic/synthetic approaches.

Week 13: Impact of Quantum Theory: quantum neural nets, quantum computation, relative onticity (Putnam); Penrose and Godel arguments

Week 14: General discussion

Readings and Reference Materials:
**Course Name and Number:** NEUR 741 (3:3:0) Introduction to Neuroimaging

**Catalog Description:** This course offers an introduction to the physics and techniques of magnetic resonance imaging (MRI) and their applications to clinical and basic neuroscience. Students will learn about the protocols used in the acquisition of images in both structural and functional contexts, and experimental paradigms applied to the exploration of cognition, learning, and development. Students will gain experience with creating an experimental design for a study and understand practical logistics involved in imaging such as MRI safety and subject screening.

**Syllabus Topics:**
- Introduction to the Physics of MRI: Resonance and Relaxation
- Pixels, Matrices, and Slices
- Spatial Encoding
- Pulse Sequences
- Image Contrast and Tissue Properties
- Image Optimization: Resolution, Signal to Noise Ratio, and Scan Time
- Image Artifacts
- Functional MRI: Physiology
- Functional MRI: Experimental Design
- Functional MRI: Analysis
- Imaging and Development: Diffusion Tensor Imaging
- Other Imaging Techniques: Spectroscopy, PET, Optical Imaging
- MRI Environment and Equipment
- MRI Safety and Quality Assurance

**Reading Resources:**


Course Name and Number: NEUR 751 (3:3:0) Applied Dynamics in Neuroscience

Catalog Description
This course will cover some recent development in the application of applied dynamics to the field of neuroscience. The emphasis of this course is on a dynamical system approach to the understanding of neural processes. Topics include neural synchrony and control, formation of waves, oscillations, and patterns within neural ensembles, network topology and dynamics of neurons, and the decoding and encoding of neural signals.

This course is interdisciplinary in design with its objective to bridge relevant concepts in applied dynamics to neuroscience. Students with backgrounds from either nonlinear dynamics and/or neuroscience will be appropriate.

TENTATIVE SYLLABUS

<table>
<thead>
<tr>
<th>Week</th>
<th>Topics</th>
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<tbody>
<tr>
<td>1</td>
<td>Introduction – Dynamical Systems and Neural Systems</td>
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<tr>
<td>2</td>
<td>Phase Plane Analysis and Bifurcations in Nonlinear Dynamical Systems</td>
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<tr>
<td>3</td>
<td>Synchrony and Oscillations in Neuroscience</td>
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<td>4</td>
<td>Models of Neural Synchrony I – Simple phase models</td>
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<td>5</td>
<td>Models of Neural Synchrony II – Conductance-based models</td>
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<td>6</td>
<td>Structure of Neural Networks - Connection Topology</td>
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<td>7</td>
<td>Computation by Excitatory and Inhibitory Networks</td>
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<tr>
<td>8</td>
<td>Traveling Waves – Experiments and Models</td>
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<td>9</td>
<td>Emergence of Sustained Activity – Learning, Memory, and Seizure</td>
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<td>10</td>
<td>Models of Sustained Neural Activity</td>
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<td>11</td>
<td>Control of Neural Activity</td>
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<tr>
<td>12</td>
<td>Linear and Nonlinear Time Series Analysis Tools</td>
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<td>13</td>
<td>Communications between Neurons and Information Processing</td>
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<tr>
<td>14</td>
<td>Decoding and Encoding of Neural Signals</td>
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</tbody>
</table>
**Course Name and Number:** NEUR 752 (3:3:0) Modern Instrumentation in Neuroscience

**Catalog Description:**

Science is interplay between experiment and theory. Much of what goes into building good experiments is engineering, i.e. knowing how to build and measure things correctly. Much of what goes into doing good science - both theoretical and experimental – requires knowledge of what is actually measured in experiments. There is often a very large difference between the variables that go into theoretical models and the numbers recorded in computers. The objective of this course is to build or expand the student's knowledge of how and what things are measured and controlled in modern bioinstrumentation. Specific topics to be covered include: Fundamental instrumentation, principles of sensing, basic electronics, computer interfaces and data acquisition, signals in biological systems, biopotential and ionic concentration measurements, optical techniques.

**TEXT BOOKS**


**SYLLABUS**

The course will be taught with two parallel tracks, one concentrating on theory, the other on applied instrumentation.

<table>
<thead>
<tr>
<th>Week</th>
<th>Theory</th>
<th>Applied &amp; hands-on</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Fundamentals of Measurement</td>
<td>Computer data acquisition</td>
</tr>
<tr>
<td>2</td>
<td>Origins of Biopotentials</td>
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<td>4</td>
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<td>5</td>
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<td>Electronics – active circuits</td>
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<td>6</td>
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<tr>
<td>7</td>
<td>Human Biopotentials</td>
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<td>8</td>
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<td>9</td>
<td>Biopotential electrodes</td>
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<td>10</td>
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<td>11</td>
<td>Chemical sensors (ion-concentration, potentiometric, amperometric)</td>
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<td>12</td>
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<td>13</td>
<td>Optical measurements</td>
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</tbody>
</table>
Course Name and Number: NEUR 851 (3:3:0) Advanced Computation and Brain Dynamics

Catalog Description: This course examines the dynamical aspects of neuroscience.

Proposed Course Content:

Week 1: Introduction to anatomy of the brain

Week 2: Experimental data on brain dynamics

Week 3, 4: Receptive Fields - input aspects: dendrites, computations - neural nets, complexity issues

Week 5, 6: Dynamical aspects of neural circuitry - output aspects (Llinas)

Week 7: Synchronicity, phase locking, timescales (Crick and Koch)

Week 8, 9: higher order monitoring (introspection and self-awareness); kinds of consciousness (Chalmers)

Week 9: Information theory: Shannon, Fischer, Penrose computability

Week 10, 11: Classical vs. Quantum neural nets

Week 12, 13: Open issues in Brain Dynamics - relevance of quantum effects

Week 14: General discussion and term project presentations
**Course Name and Number:** NEUR 998 (1-6:0:0) Doctoral Dissertation Proposal

**Catalog Description:** To write research proposal for the doctoral dissertation.

**Course Name and Number:** NEUR 999 (1-24:0:0) Doctoral Dissertation

**Catalog Description:** Research in the concentration pertinent to the student’s program of study. Students may enroll for credits in this course once their research proposal has been approved. A maximum of 24 credits can be applied toward their degree.
George Mason University
Graduate Course Approval/Inventory Form

Please complete this form and attach a copy of the syllabus for new courses. Forward it as an email attachment to the Secretary of the Graduate Council. A printed copy of the form with signatures should be brought to the Graduate Council Meeting. Complete the Coordinator Form on page 2, if changes in this course will affect other units.

Please indicate:  __X__ NEW   ____ MODIFY   ____ DELETE

Local Unit:  SSC/CAS/Krasnow   Graduate Council Approval Date: 10/22/03

Course Abbreviation: NEUR   Number: 701

Full Course Title: Neurophysiology Laboratory

Abbreviated Course Title (24 characters max.): Neurophysiology Laboratory

Credit hours: 2   Program of Record:

Repeatable for Credit?  ___ D=Yes, not within same term   Up to hours
___ T=Yes, within the same term   Up to hours
__X__ N=Cannot be repeated for credit

Activity Code (please indicate):  __ Lecture (LEC)   __X__ Lab (LAB)   ___ Recitation (RCT)
___ Studio (STU)   ___ Internship (INT)   ___ Independent Study (IND)   ___ Seminar (SEM)

Catalog Credit Format 2:0:6   Course Level:  GF(500-600)   __X__ GA(700+)

Maximum Enrollment: 20   For NEW courses, first term to be offered: Fall 2004
Prerequisites: NEUR 602/BIOS 721Cellular Neuroscience

Catalog Description (35 words or less)  Please use catalog format and attach a copy of the syllabus for new courses:
Hands on training in current techniques of modern neurophysiology. The course (1) acquaints the student with the theoretical basis of each technique, (2) trains the student in the laboratory skills necessary to perform each technique. Includes both intracellular and extracellular recording techniques. Preparations include both vertebrates and invertebrates. Meets once weekly for 6 hours. Open to candidates in the neuroscience Ph.D. program.

For MODIFIED or DELETED courses as appropriate:
Last term offered:  Previous Course Abbreviation:  Previous number:

Description of modification:
APPROVAL SIGNATURES:
Submitted by: ________________________________ email:
__________________
Department/Program: ________________________________ Date:
__________________
College Committee: ________________________________ Date:
__________________
Graduate Council Representative: ________________________________ Date:
__________________
George Mason University
Graduate Course Approval/Inventory Form

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Please indicate:  __X__ NEW  ____ MODIFY  ____ DELETE

Local Unit:  SSC/CAS/Krasnow  Graduate Council Approval Date: 10/22/03

Course Abbreviation: NEUR  Number: 709

Full Course Title: Neuroscience Seminars

Abbreviated Course Title (24 characters max.): Neuroscience Seminars

Credit hours: 1  Program of Record:  

Repeatable for Credit?  

__D=Yes, not within same term  Up to hours  

__T=Yes, within the same term  Up to hours  

__X_N=Cannot be repeated for credit

Activity Code (please indicate):  

__X_Lecture (LEC)  ____ Lab (LAB)  ____ Recitation (RCT)  

____ Studio (STU)  ____ Internship (INT)  ____ Independent Study (IND)  ____ Seminar (SEM)

Catalog Credit Format 1:1:0  Course Level: GF(500-600)  ____ GA(700+)  __X__

Maximum Enrollment: 20  For NEW courses, first term to be offered: Fall 2004

Prerequisites: Admission to Neuroscience Ph.D. program

Catalog Description (35 words or less)  Please use catalog format and attach a copy of the syllabus for new courses:

Special seminar series for first year neuroscience Ph.D. students. The purpose of this seminar series is for students to both learn about the research at the University and to select their lab rotations and eventual thesis topic. Each week, a different neuroscience laboratory and principal investigator gives two lectures to students. The first one is an introductory lecture on the neuroscience basics necessary to appreciate the laboratory research theme and mission. The second is a more practical description (and possibly lab visit) of the active research program of the lab, and of the open projects for both lab rotations and PhD theses.

For MODIFIED or DELETED courses as appropriate:

Last term offered:  Previous Course Abbreviation:  Previous number:
Description of modification:

**APPROVAL SIGNATURES:**
Submitted by: ________________________________ email: ________________________________
Department/Program: __________________________________ Date: __________________
College Committee: __________________________________ Date: __________________
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George Mason University
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Please indicate:  ___ X ___ NEW  _____ MODIFY  _____ DELETE

Local Unit:  SSC/CAS/Krasnow  Graduate Council Approval Date: 10/22/03

Course Abbreviation:  NEUR  Number:  710

Full Course Title:  Special Topics in Neuroscience

Abbreviated Course Title (24 characters max.):  Special Topics in Neuroscience

Credit hours:  1  Program of Record:

Repeatable for Credit?  ___ D=Yes, not within same term  Up to  hours
___ T=Yes, within the same term  Up to  hours
__ X _ N=Cannot be repeated for credit

Activity Code (please indicate):  ___ Lecture (LEC)  ____ Lab (LAB)  ____ Recitation (RCT)
____ Studio (STU)  ____ Internship (INT)  ____ Independent Study (IND)  ___ Seminar (SEM)

Catalog Credit Format  1:1:0  Course Level:  GF(500-600)  ____ GA(700+)  __ X

Maximum Enrollment:  20  For NEW courses, first term to be offered:  Fall 2004
Prerequisites:  Admission to Neuroscience Ph.D. program

Catalog Description (35 words or less)  Please use catalog format and attach a copy of the syllabus for new courses:
This seminar examines a number of topics in the neurosciences including neurogenetics, neural imaging, and the competing computational and biological approaches to the mind.

For MODIFIED or DELETED courses as appropriate:
Last term offered:  Previous Course Abbreviation:  Previous number:

Description of modification:
APPROVAL SIGNATURES:
Submitted by:  ________________________________ email:  
________________________
Department/Program:  ________________________________ Date:  
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Please indicate:  

X  NEW  
MODIFY  
DELETE

Local Unit:  SSC/CAS/Krasnow  
Graduate Council Approval Date: 10/22/03

Course Abbreviation: NEUR  
Number: 741

Full Course Title: Introduction to Neuroimaging

Abbreviated Course Title (24 characters max.): Introduction to Neuroimaging

Credit hours: 3  
Program of Record:

Repeatable for Credit?  

D=Yes, not within same term  
T=Yes, within the same term  
N=Cannot be repeated for credit

Activity Code (please indicate):  

X  Lecture (LEC)  
Lab (LAB)  
Recitation (RCT)  
Studio (STU)  
Internship (INT)  
Independent Study (IND)

Seminar (SEM)

Catalog Credit Format 3:3:0  
Course Level: GF(500-600)  
GA(700+)  

Maximum Enrollment: 20  
For NEW courses, first term to be offered: Fall 2004  
Prerequisites: BIOS 721, PSYC 531, or permission of instructor

Catalog Description (35 words or less)  
Please use catalog format and attach a copy of the syllabus for new courses:

This course offers an introduction to the physics and techniques of magnetic resonance imaging (MRI) and their applications to clinical and basic neuroscience. Students will learn about the protocols used in the acquisition of images in both structural and functional contexts, and experimental paradigms applied to the exploration of cognition, learning, and development. Students will gain experience with creating an experimental design for a study and understand practical logistics involved in imaging such as MRI safety and subject screening.

For MODIFIED or DELETED courses as appropriate:
Last term offered: Previous Course Abbreviation: Previous number:

Description of modification:

**APPROVAL SIGNATURES:**
Submitted by: ________________________________ email: ________________________________

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Department/Program: ________________________________ Date: ________________________________

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College Committee: ________________________________ Date: ________________________________

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Graduate Council Representative: ________________________________ Date: ________________________________
George Mason University
Graduate Course Approval/Inventory Form
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Please indicate:  
\( \_X\) NEW  \( \__\) MODIFY  \( \__\) DELETE

Local Unit: SSC/CAS/Krasnow  Graduate Council Approval Date: 10/22/03

Course Abbreviation: NEUR  Number: 751

Full Course Title: Applied Dynamics in Neuroscience

Abbreviated Course Title (24 characters max.): Applied Dynamics in Neuroscience

Credit hours: 3  Program of Record: NEUR

Repeatable for Credit?  
\( \_D\) =Yes, not within same term  Up to hours
\( \_T\) =Yes, within the same term  Up to hours
\( \_X\) =Cannot be repeated for credit

Activity Code (please indicate):  
\( \_X\) Lecture (LEC)  \( \__\) Lab (LAB)  \( \__\) Recitation (RCT)
\( \__\) Studio (STU)  \( \__\) Internship (INT)  \( \__\) Independent Study (IND)  \( \__\) Seminar (SEM)

Catalog Credit Format 3:3:0  Course Level: GF(500-600)  \( \__\) GA(700+)  \( \_X\)

Maximum Enrollment: 20  For NEW courses, first term to be offered: Fall 2004
Prerequisites: CSI 734, PSYC 531, or permission of instructor

Catalog Description (35 words or less)  Please use catalog format and attach a copy of the syllabus for new courses:
This course will cover some recent development in the application of applied dynamics to the field of neuroscience. The emphasis of this course is on a dynamical system approach to the understanding of neural processes. Topics include neural synchrony and control, formation of waves, oscillations, and patterns within neural ensembles, network topology and dynamics of neurons, and the decoding and encoding of neural signals.

For MODIFIED or DELETED courses as appropriate:
Last term offered:  Previous Course Abbreviation:  Previous number:
Description of modification:

APPROVAL SIGNATURES:
Submitted by: ________________________________ email: ________________________________

Department/Program: ________________________________ Date: ________________________________

College Committee: ________________________________ Date: ________________________________

Graduate Council Representative: ________________________________ Date: ________________________________
George Mason University
Graduate Course Approval/Inventory Form

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Please indicate:  

____ NEW  _____ MODIFY  _____ DELETE

Local Unit:  SSC/CAS/Krasnow  
Graduate Council Approval Date: 10/22/03

Course Abbreviation: NEUR  
Number: 752

Full Course Title: Modern Instrumentation in Neuroscience

Abbreviated Course Title (24 characters max.): Modern Instrumentation in Neuroscience

Credit hours: 3  
Program of Record: NEUR

Repeatable for Credit?  

___ D=Yes, not within same term  
___ T=Yes, within the same term  
___ N=Cannot be repeated for credit  

Up to hours

Activity Code (please indicate):  

____ Lecture (LEC)  ___ Lab (LAB)  ___ Recitation (RCT)  
___ Studio (STU)  ___ Internship (INT)  ___ Independent Study (IND)  ___ Seminar (SEM)

Catalog Credit Format 3:3:0  
Course Level: GF(500-600) ___  GA(700+)  ___

Maximum Enrollment: 20  
For NEW courses, first term to be offered: Fall 2004

Prerequisites: BIOS 721, CSI 734, or permission of instructor

Catalog Description (35 words or less)  
Please use catalog format and attach a copy of the syllabus for new courses:

Science is interplay between experiment and theory. Much of what goes into building good experiments is engineering, i.e. knowing how to build and measure things correctly. Much of what goes into doing good science - both theoretical and experimental – requires knowledge of what is actually measured in experiments. There is often a very large difference between the variables that go into theoretical models and the numbers recorded in computers. The objective of this course is to build or expand the student's knowledge of how and what things are measured and controlled in modern bioinstrumentation.

For MODIFIED or DELETED courses as appropriate:

Last term offered:  
Previous Course Abbreviation:  
Previous number:
Description of modification:

**APPROVAL SIGNATURES:**
Submitted by: ________________________________ email: __________________

Department/Program: ________________________________ Date: ________________

College Committee: ________________________________ Date: ________________

Graduate Council Representative: ________________________________ Date: ________________
George Mason University
Graduate Course Approval/Inventory Form

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Please indicate:  

   _X_ NEW ______ MODIFY ______ DELETE

Local Unit:  SSC/CAS/Krasnow  
Graduate Council Approval Date:  10/22/03

Course Abbreviation:  NEUR  
Number:  851

Full Course Title:  Advanced Computation and Brain Dynamics

Abbreviated Course Title (24 characters max.):  Advanced Computation and Brain Dynamics

Credit hours:  3  
Program of Record:  NEUR

Repeatable for Credit?  

   _D_ Yes, not within same term  Up to hours
   _T_ Yes, within the same term  Up to hours
   _X_ N=Cannot be repeated for credit

Activity Code (please indicate):  

   _X_ Lecture (LEC)  ___ Lab (LAB)  ___ Recitation (RCT)
   _X_ Studio (STU)  ___ Internship (INT)  ___ Independent Study (IND)  ___ Seminar (SEM)

Catalog Credit Format  3:3:0  

Course Level:  GF(500-600)  ___  GA(700+)  _X_

Maximum Enrollment:  20  
For NEW courses, first term to be offered: Fall 2004
Prerequisites:  CSI 734, PSCY 531

Catalog Description (35 words or less)  Please use catalog format and attach a copy of the syllabus for new courses:

This course focuses on an in-depth study of the state-of-the-art in advanced brain dynamics. Using mathematical and physical models, the lectures will cover the neurodynamical aspects of neural nets, receptive fields, ion-channels, inter-cortical interactions, phase-locking, synchronicity, and the possible non-trivial role of quantum effects. The material presented will emphasize the latest experimental approaches developed by Llinas and Crick.
For MODIFIED or DELETED courses as appropriate:
Last term offered: Previous Course Abbreviation: Previous number:

Description of modification:

APPROVAL SIGNATURES:
Submitted by: email:

Department/Program: Date:

College Committee: Date:

Graduate Council Representative: Date:
Please complete this form and attach a copy of the syllabus for new courses. Forward it as an email attachment to the Secretary of the Graduate Council. A printed copy of the form with signatures should be brought to the Graduate Council Meeting. Complete the Coordinator Form on page 2, if changes in this course will affect other units.

Please indicate:  

[X]  NEW  
[ ]  MODIFY  
[ ]  DELETE  

Local Unit:  SSC/CAS/Krasnow  
Graduate Council Approval Date:  10/22/03  

Course Abbreviation:  NEUR  
Number:  998  

Full Course Title: Doctoral Dissertation Proposal  
Abbreviated Course Title (24 characters max.): Doctoral Dissertation Proposal  

Credit hours:  1-6  
Program of Record:  NEUR  

Repeatable for Credit?  

[X]  D=Yes, not within same term  
[ ]  T=Yes, within the same term  
[ ]  N=Cannot be repeated for credit  

Up to 12 hours  
Up to hours  
Cannot be repeated for credit  

Activity Code  (please indicate):  

[Lecture (LEC)]  
[Lab (LAB)]  
[Recitation (RCT)]  
[Studio (STU)]  
[Internship (INT)]  
[Independent Study (IND)]  
[Seminar (SEM)]  

Catalog Credit Format  1-6:0:0  
Course Level:  GF(500-600)  
[GA(700+)]  
[X]  

Maximum Enrollment:  20  
For NEW courses, first term to be offered: Fall 2004  
Prerequisites:  Admission into the Neuroscience Ph.D. program  

Catalog Description  (35 words or less)  
Please use catalog format and attach a copy of the syllabus for new courses:  
Preparation of doctoral dissertation proposal  

For MODIFIED or DELETED courses as appropriate:  
Last term offered:  
Previous Course Abbreviation:  
Previous number:  

54
Description of modification:

**APPROVAL SIGNATURES:**
Submitted by: ________________________________ email: ________________________________

Department/Program: ________________________________ Date: ________________________________

College Committee: ________________________________ Date: ________________________________

Graduate Council Representative: ________________________________ Date: ________________________________
George Mason University
Graduate Course Approval/Inventory Form
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Please indicate:   ____ NEW   ____ MODIFY   ____ DELETE

Local Unit: SSC/CAS/Krasnow
Graduate Council Approval Date: 10/22/03

Course Abbreviation: NEUR   Number: 999

Full Course Title: Doctoral Dissertation
Abbreviated Course Title (24 characters max.): Doctoral Dissertation

Credit hours: 1-24 Program of Record: NEUR

Repeatable for Credit?   X D=Yes, not within same term   Up to 24 hours
   ___ T=Yes, within the same term   Up to hours
   ___ N=Cannot be repeated for credit

Activity Code (please indicate):   Lecture (LEC) Lab (LAB) Recitation (RCT)
   ____ Studio (STU) Internship (INT) Independent Study (IND) Seminar (SEM)

Catalog Credit Format 1-24:0:0 Course Level: GF(500-600) GA(700+) X

Maximum Enrollment: 20 For NEW courses, first term to be offered: Fall 2004
Prerequisites: Advancement to doctoral candidacy in the Neuroscience Ph.D. program

Catalog Description (35 words or less) Please use catalog format and attach a copy of the syllabus for new courses:
Research in the concentration pertinent to the student’s program of study. Students may enroll for credits in this course once their research proposal has been approved. A maximum of 24 credits can be applied toward their degree.

For MODIFIED or DELETED courses as appropriate: