

NEUROSCIENCE

Graduate Program Head	Alistair Barber
Program Code	NEURS
Campus(es)	Hershey (Ph.D., M.S.) University Park (Ph.D., M.S.)
Degrees Conferred	Doctor of Philosophy (Ph.D.) Master of Science (M.S.) Dual-Title Ph.D. in Neuroscience and Clinical and Translational Sciences M.D./Ph.D.
The Graduate Faculty	View (https://secure.gradsch.psu.edu/gpms/index.cfm?searchType=fac&prog=NEURS)

The Neuroscience (NEURS) Graduate Program provides students curricular training with a broad focus on neuroscience, and the opportunity for concentrated research in a variety of disciplinary approaches to neuroscience such as biochemistry, cell biology, embryology, genetics, immunology, neuroscience, pharmacology, physiology, structural biology, and virology. Students receive rigorous training that provides the skills necessary to be leaders in biomedical research and other endeavors that benefit from a rigorous scientific background, including education, law, journalism, and public policy.

The Neuroscience Graduate Program is an interdepartmental program that engages faculty from multiple basic science and clinical science departments. This broad-reaching Program provides students a wide ranging understanding of multiple disciplines with specific expertise in a chosen area, and encourages interdisciplinary research that is the hallmark of biomedical sciences in the 21st century.

Admission Requirements

Applicants apply for admission to the program via the Graduate School application for admission (<http://gradschool.psu.edu/prospective-students/how-to-apply>). Requirements listed here are in addition to Graduate Council policies listed under GCAC-300 Admissions (<http://gradschool.psu.edu/graduate-education-policies>).

Prospective applicants should have a bachelor's degree in a biological, physical, or behavioral science and are expected to have taken undergraduate courses in biology, chemistry, physics, and mathematics. Applicants are expected to have a 3.0 (B) grade-point average or better. Neuroscience courses are desirable but not essential and research experience is an advantage. The General Test of the Graduate Record Examinations (GRE), or a comparable substitute examination accepted by the Neuroscience graduate program, is required for all applicants.

A complete application includes:

- completed online Graduate School application (<http://gradschool.psu.edu/prospective-students/how-to-apply>) with personal statement of purpose;
- GRE scores;
- official transcripts from all post-secondary institutions attended (<http://www.gradschool.psu.edu/prospective-students/how-to-apply/new-applicants/requirements-for-graduate-admission>);

- three letters of recommendation; and
- TOEFL scores (if applicable).

The language of instruction at Penn State is English. English proficiency test scores (TOEFL/IELTS) may be required for international applicants. See GCAC-305 Admission Requirements for International Students (<http://gradschool.psu.edu/graduate-education-policies/gcac/gcac-300/gcac-305-admission-requirements-international-students>) for more information.

The application deadline is December 15 for admission in the following fall.

Qualified applicants generally will be requested to visit the College of Medicine in Hershey, PA for an interview. Admission is based on evaluation of the undergraduate transcript, GRE scores, personal statement of purpose, letters of recommendation, and performance at the interview.

Degree Requirements

Master of Science (M.S.)

Requirements listed here are in addition to Graduate Council policies listed under GCAC-600 Research Degree Requirements. (<http://gradschool.psu.edu/graduate-education-policies>)

During the first year, students complete three research rotations that expose them to the wide range of research interests of The Pennsylvania State University Graduate Faculty from both basic and clinical science departments at the College of Medicine in Hershey. These rotations serve to inform the students with regard to choosing an adviser and forming a committee. In addition, students are advised to take ethics, statistics and electives.

A minimum of 30 credits at the 400, 500, 600, or 800 level is required for the M.S., with least 18 credits at the 500 and 600 level, combined. A thesis is required, and a minimum of six (6) thesis research credits (NEURO 600) must be taken in Neuroscience. The thesis must be accepted by the advisers and/or committee members, the head of the graduate program, and the Graduate School, and the student must pass a thesis defense.

Code	Title	Credits
Required Courses		
NEURO 511	Neurobiology II	3
NEURO 520	Cellular and Molecular Neuroscience	3
NEURO 521	Systems Neuroscience	3
NEURO 522	Seminars in Neuroscience I	2
NEURO 523	Seminars in Neuroscience II	2
NEURO 530	Professional Development and Responsible Conduct in Science	1
BMS 591	Biomedical Research Ethics	1
Electives		
The remaining elective credits may be chosen from a list of approved electives maintained by the program office.		9
Culminating Experience		
NEURO 600	Thesis Research	6
Total Credits		30

Doctor of Philosophy (Ph.D.)

Requirements listed here are in addition to Graduate Council policies listed under GCAC-600 Research Degree Requirements. (<http://gradschool.psu.edu/graduate-education-policies>)

A minimum of 32 credits is required for the Ph.D. degree:

Code	Title	Credits
Required Courses		
<i>Core Requirements</i>		
BMS 502	Cell and Systems Biology	3
BMS 503	Flow of Cellular Information	3
NEURO 511	Neurobiology II	3
NEURO 520	Cellular and Molecular Neuroscience	3
NEURO 521	Systems Neuroscience	3
<i>Program Requirements</i>		
PHS 520	Principles of Biostatistics	3
NEURO 522	Seminars in Neuroscience I	2
NEURO 523	Seminars in Neuroscience II	2
NEURO 530	Professional Development and Responsible Conduct in Science	1
NEURO 590	Colloquium	2
BMS 591	Biomedical Research Ethics	1
<i>Additional Required Course</i>		
NEURO 602	Supervised Experience in College Teaching ¹	1
Electives		
A minimum of 6 elective credits is required.		6
Total Credits		32

¹ In addition, Ph.D. students are required to complete 1 credit of NEURO 602; however, this 1 credit cannot be counted towards the minimum 32 credits required.

A student's Ph.D. committee can require additional course work depending on the student's background and research plans.

Ph.D. degree requirements include successful completion of the following:

- approved graduate course work,
- English Competence requirements,
- a qualifying examination, which entails an oral presentation and a written examination on anatomical course work,
- a comprehensive examination, and
- a final oral examination (the dissertation defense).

To earn the Ph.D. degree, doctoral candidates must write a dissertation that is accepted by the Ph.D. committee, the head of the graduate program, and the Graduate School.

Dual-Titles

Dual-Title Ph.D. in Neuroscience and Clinical and Translational Sciences

Requirements listed here are in addition to requirements listed in GCAC-208 Dual-Title Graduate Degree Programs (<http://gradschool.psu.edu/graduate-education-policies/gcac/gcac-200/gcac-208-dual-title-graduate-degree-programs>).

Admission Requirements

Potential dual-title students can express an interest in the CTS dual-title as early as during the recruitment process for the Neuroscience Graduate Program. Students must apply and be admitted to the graduate program in Neuroscience and The Graduate School before they can apply for admission to the dual-title degree program. After admission to their primary program, students must apply for admission to and meet the admission requirements of the CTS dual-title program. Refer to the Admission Requirements section of the CTS Bulletin page (<http://bulletins.psu.edu/graduate/programs/majors/clinical-translational-sciences>). Doctoral students must be admitted into the dual-title degree program in CTS prior to taking the qualifying exam in Neuroscience.

Students interested in the dual-title Ph.D. will be considered for admission to the Clinical and Translational Sciences Program by a committee consisting of the Clinical and Translational Sciences Program co-directors and faculty affiliated with the Clinical and Translational Sciences Dual-Title Program. To apply, the student must submit the following documentation to the Clinical and Translational Sciences Dual-title Program:

1. A statement of interest, including the applicant's reasons for pursuing a career that includes clinical/translational science.
2. A letter from the applicant's research adviser which endorses the applicant's participation in the Clinical and Translational Sciences dual-title program.
3. A letter of support from the head of Neuroscience. If the applicant has not yet selected a research adviser, the program head's letter should describe the program's support of the applicant's desire to incorporate clinical/translational research in the applicant's training plans.
4. A description of the applicant's academic performance to date.

Degree Requirements

To qualify for the dual-title degree, students must satisfy the degree requirements for the degree they are enrolled in Neuroscience. In addition, students must complete the degree requirements for the dual-title in CTS, listed on the CTS Bulletin page (<http://bulletins.psu.edu/graduate/programs/majors/clinical-translational-sciences>). Up to 7 credits of course work may be used to satisfy both Neuroscience and CTS degree requirements. In addition, a student may request to double count additional credits up to a maximum of 12. An increase in double-counted credits will be determined by the CTS Program on a case-by-case basis.

Neuroscience graduate students accepted to the Clinical and Translational Sciences Dual-Title Program will take the qualifying exam by the end of the fourth semester of the graduate program:

1. to allow exposure to the Clinical and Translational Sciences curriculum in the Spring semester of the first year and Fall semester of the second year, which will prepare the students for the integrated content of the dual-title qualifying exam, and
2. to allow sufficient time to identify and assure commitment of an appropriate dissertation adviser who embraces the dual-title program of the student.

During the qualifying examination, the student will also be assessed for the dual-title program, and at least one member of the qualifying exam committee must come from the dual-title program. Faculty members who hold appointments in both programs' Graduate Faculty may serve in a combined role.

In addition to the general Graduate Council requirements for Ph.D. committees (<http://gradschool.psu.edu/graduate-education-policies/gcac/gcac-600/phd-dissertation-committee-formation>), the Ph.D. committee of a Neuroscience and Clinical and Translational Sciences dual-title doctoral degree candidate must include at least one member of the Clinical and Translational Sciences Graduate Faculty. Faculty members who hold appointments in both programs' Graduate Faculty may serve in a combined role. If the chair of the Ph.D. committee is not also a member of the Graduate Faculty in CTS, the member of the committee representing CTS must be appointed as co-chair. The CTS representative on the student's Ph.D. committee will develop questions for and participate in the evaluation of the comprehensive examination.

Students enrolled in the dual-title program are required to write and orally defend a dissertation on a topic that is approved in advance by their Ph.D. committee and reflects their original research and expertise in both Neuroscience and Clinical and Translational Sciences. Upon completion of the doctoral dissertation, the candidate must pass a final oral examination (the dissertation defense) to earn the Ph.D. degree. The dissertation must be accepted by the Ph.D. committee, the head of the graduate program, and the Graduate School.

Joint Degrees

Joint M.D./Ph.D. with the college of Medicine

Requirements listed here are in addition to requirements listed in GCAC-211 Joint Degree Programs (<http://gradschool.psu.edu/graduate-education-policies/gcac/gcac-200/gcac-211-joint-degree-programs>).

Admission Requirements

Applicants to the joint M.D./Ph.D. degree program must apply and be admitted to both the Neuroscience graduate program and the College of Medicine.

Students interested in simultaneously pursuing an M.D. and Ph.D. degree must apply to the College of Medicine M.D. program using the national American Medical College Application Service (AMCAS) application system and indicate their intent to pursue the joint degree program. Admission requirements and applications for admission for Penn State College of Medicine are available at the M.D. Program (<http://med.psu.edu/md>) section of the Penn State College of Medicine website. The College of Medicine M.D./Ph.D. Admissions Committee reviews applications and evaluates applicants for acceptance into both the M.D. and Ph.D. program. Students not accepted into the joint degree program can be referred to either the M.D. or Ph.D. program, depending on their qualifications and interests.

After the review committee has accepted an applicant to the joint degree program, s/he must apply and be admitted to the Graduate School (<http://www.gradschool.psu.edu/prospective-students/how-to-apply>) for admission to the graduate program. Requirements for the joint degree, additional to the general admission requirements for the Ph.D. degree, are:

- **Academic Achievement.** Applicants to our program generally have very strong grades and MCAT scores. In recent years, successful applicants have an average GPA of 3.75 and total MCAT scores of >85 percentile. Applicants are not required to take the GREs.
- **Research Experience.** We are especially interested in students with a strong and sustained background in research. Students who have spent 1-2 years after graduation conducting research are strongly encouraged to apply. Alternatively, in-depth research experience as an undergraduate can suffice.

- **Recommendations.** We are especially interested in receiving letters of recommendation from faculty with whom you conducted research and who can comment on your passion and potential for research.
- **Goals.** Applicants must be able to clearly articulate the reasons for pursuing the joint degree.
- **International Students.** All qualified students are eligible to apply regardless of citizenship.

Degree Requirements

Students must fulfill all requirements for each degree in order to be awarded that degree, subject to the double-counting of credits as outlined below. Degree requirements for the M.D. program are listed on the M.D. Program (<http://med.psu.edu/md>) section of the Penn State College of Medicine website.

During the first two years of medical school, the student conducts at least three research rotations. In addition, students are required to take BMS 506A and BMS 506B during the M1 (Spring) and M2 (Fall), as well as either a 1 credit course in genetics or immunology. After successful completion of the first two years of medical school, the student joins their dissertation lab in the Neuroscience graduate program.

During the summer after the second year of medical school M.D./Ph.D. students take Step 1 of the United States Medical Licensing Examination (USMLE), which serves in lieu of the knowledge-based portion of the qualifying examination for the Neuroscience program.

The Ph.D. committee of an M.D./Ph.D. student in the Neuroscience program is formed upon entry into the dissertation laboratory. In addition to the general Graduate Council requirements for Ph.D. committees (<http://gradschool.psu.edu/graduate-education-policies/gcac/gcac-600/phd-dissertation-committee-formation>), the committee must include at least two members of the Neuroscience program Graduate Faculty and one M.D./Ph.D. steering committee member.

In addition to taking the required courses NEURO 590, BMS 591, and PHS 520, students are required to take the core neuroscience courses: NEURO 521, NEURO 522, NEURO 523, and NEURO 530. A minimum of 4 elective credits is required. Other elective courses are selected in consultation with the student's dissertation adviser and Ph.D. committee.

Code	Title	Credits
Required Courses		
NEURO 521	Systems Neuroscience	3
NEURO 522	Seminars in Neuroscience I	2
NEURO 523	Seminars in Neuroscience II	2
NEURO 530	Professional Development and Responsible Conduct in Science	1
NEURO 590	Colloquium	2
BMS 591	Biomedical Research Ethics	1
PHS 520	Principles of Biostatistics	3
Electives		
A minimum of 4 elective credits is required. Other elective courses are selected in consultation with the student's dissertation adviser and Ph.D. committee.		4
Total Credits		18

The Neuroscience program will accept passing grades in the medical school courses SPM 711 (11 cr.) and NBS 723 (3 cr.) in lieu of following 12 required credits for the Neuroscience Ph.D.:

Code	Title	Credits
BMS 501	Regulation of Cellular & Systemic Energy Metabolism	3
BMS 502	Cell and Systems Biology	3
NEURO 520	Cellular and Molecular Neuroscience	3
NEURO 511	Neurobiology II	3

M.D./Ph.D. students are not required to take NEURO 602 (1 cr.).

The M.D./Ph.D. student prepares a written comprehensive examination in the format of a grant application and gives an oral presentation of this proposal to their Ph.D. committee.

M.D./Ph.D. candidates are required to have at least one paper accepted for publication in a major peer-reviewed scientific journal prior to the final oral examination, and this must be accepted before they return to the third year of medical school. A student may petition to waive this requirement due to extenuating circumstances (e.g., adviser relocation, abnormal issues with publication process). All waivers must be approved by the Vice Dean for Research and Graduate Studies of the College of Medicine.

A dissertation must be prepared and defended by each M.D./Ph.D. candidate prior to returning to the M3 year of medical school. The dissertation must be accepted by the Ph.D. committee, the head of the graduate program, and the Graduate School, and the student must pass the final oral examination (the dissertation defense).

If a student decides not to return to medical school, or for some other reason is not able to complete the last two years of medical school, but they have successfully completed their Ph.D. dissertation and final oral examination and met all other degree requirements of the Neuroscience program, they will be able to complete the Ph.D. The latter will be conferred after the student notifies the program that she/he wishes to withdraw from the M.D. program and completes all requirements for conferral of the graduate degree.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the Tuition & Funding (<http://gradschool.psu.edu/graduate-funding>) section of The Graduate School's website. Students on graduate assistantships must adhere to the course load limits (<http://gradschool.psu.edu/graduate-education-policies/gsad/gsad-900/gsad-901-graduate-assistants>) set by The Graduate School.

All support is continuous for the first year from the Neuroscience program. Support in years two and above, when the student is conducting dissertation research, must be acquired from either the basic science department in which the candidate elects to pursue his/her minor or from funds available from the dissertation adviser. These funds must be secured by the student in conjunction with his/her adviser.

Courses

Graduate courses carry numbers from 500 to 699 and 800 to 899. Advanced undergraduate courses numbered between 400 and 499 may be used to meet some graduate degree requirements when taken by graduate students. Courses below the 400 level may not. A graduate student may register for or audit these courses in order to make up deficiencies or to fill in gaps in previous education but not to meet requirements for an advanced degree.

Neuroscience (NEURO) Course List (<https://bulletins.psu.edu/university-course-descriptions/graduate/neuro>)

Learning Outcomes

1. Describe the structural-functional organization of the nervous system at the cellular and systems levels
2. Describe the basic principles of neurotransmission
3. Explain the techniques used to analyze the structure and function of the nervous system
4. Develop testable hypotheses aimed at elucidating the structure or function of the nervous system
5. Develop an experimental plan that tests a specific set of hypotheses about nervous system structure or function following accepted professional standards for ensuring reproducibility
6. Conduct neuroscience research in which data are collected using ethical and professional standards
7. Present the results of a research project in a lucid and logical manner in both oral and written formats

Contact

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Program Website View (<http://med.psu.edu/neuroscience-phd>)

Campus University Park

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Program Website View (<https://www.huck.psu.edu/graduate-programs/neuroscience>)