Graduate Council Curriculum Report

The Graduate Council Curriculum Report (GCCR), which includes all graduate curricular proposals approved through the Graduate Council curricular review process, is published 12 times each calendar year.

Questions/comments regarding the GCCR or its contents may be directed to the Director of Graduate Education Administration.

March 8, 2017

Graduate Degree Programs

ADD

Additive Manufacturing and Design – new graduate program offering M.S. and M.Eng. degrees (College of Engineering), page 7

CHANGE

Biomedical Sciences – add option in Cellular and Integrative Physiology and change degree requirements (College of Medicine), page 47

Food Science – adopt dual-title Ph.D. and M.S. in International Agriculture and Development (College of Agricultural Sciences), page 112

Information Systems – add an IUG combining the B.S. in Information Systems and M.S. in Information Systems (Penn State Harrisburg), page 131

Public Health – change degree requirements (College of Medicine), page 176

Graduate Courses

ADD

CIPA 820
Criminal Procedure
CRIMINAL PROCEDURE (3)
This course provides a survey of criminal procedure and related constitutional law.
Section 1 of the course explores the origins and evolution of criminal procedure, from its ancient roots through colonial times, the due process revolution, and modern law.
Section 2 examines sources of modern criminal procedure, including statutory law, Supreme Court opinions, other case law, rules, regulations, and organizations’ rules and regulations.
Section 3 examines the Fourth Amendment and the evolution of search and seizure laws, including arrests, proper use of force, search warrants, and searches of places and things. The section presents older and more recent psychological conceptions of crime.
Section 4 examines the Fifth Amendment, the federal due process clause, and the right to be free from forced self-incrimination; the Confrontation Clause; and the rights and responsibilities of all related criminal justice stakeholders in relation to these issues, including victims and defendants. Section 5 examines the Sixth Amendment, the right to counsel, evidence procurement and development, and criminal trial procedures. Section 6 examines the Eighth Amendment, the relationship between the Eighth and the Fourteenth Amendments, pretrial versus post-conviction procedures, sentencing and correctional procedures, and the cruel and unusual punishment clause. Section 7 examines the Fourteenth Amendment, substantive due process clause, the equal protection clause, civil rights litigation, and the role of the writ of habeas corpus in criminal procedure. Section 8 allows students to demonstrate that they have mastered the above through a case study of a criminal case that has occurred within the past twelve months, or is ongoing.

**PROPOSED START: FA2017**

**CJPA 865**
Criminal Justice Ethics in a Diverse Society  
CRIM JUSTICE ETHIC (3)  
This course provides a survey of ethical systems and theories.  
Section 1 provides an overview of the study of ethics, with definitions and a discussion of the parameters of ethical analysis.  
Section 2 presents the major ethical systems (utilitarianism, ethical formalism, religion, ethics of care, virtue ethics).  
Section 3 examines the origins of the concept of justice, distributive justice, corrective justice, substantive justice, procedural justice, immoral laws and the moral person, and restorative justice.  
Section 4 explains the theories of moral development, biological factors, learning theory, Kohlberg’s moral stage theory, teaching ethics, and avoiding cynicism and burnout.  
Section 5 discusses the role of police in society as crime fighter or public servant, police power and discretion, and the police subculture.  
Section 6 examines police discretion and discrimination, discretion in criminal investigations, and discretion and the use of force.  
Section 7 examines police misconduct and corruption as a worldwide problem, including international measures of corruption, on-duty use of drugs and alcohol, sexual misconduct, and criminal behavior by police.  
Section 8 examines the role of law, the law and legal behavior, justifications for law, and the various paradigms of law.  
Section 9 presents issues of discretion and dilemmas for the defense and the prosecution.  
Section 10 discusses ethical misconduct in the courts and the explanations and methods of response to the misconduct.  
Section 11 describes the issues involving discretion of correctional officers, treatment staff, and probation and parole officers.  
**PROPOSED START: FA2017**

**EME 529**
Foundations of Economic Welfare Analysis  
FOUND ECON WELFARE (3)  
How do we know which forms of economic organization are preferred to others? How do we evaluate who wins and loses within the economic sphere? How do we know when the allocation of goods and services by the economic system is societally optimal? How do we define what is societally optimal?
When do government policies improve societal welfare and when do they worsen it? How do we measure societal welfare? When should governments intervene in the economic system and to what extent? How large should the economic system be relative to the natural system? How much should present generations consume relative to future ones?

Welfare economics is a branch of economics that seeks to answer these questions. In this course we will develop the concepts and tools needed to do so. Our primary focus will be on evaluating the efficiency and equity implications of public policies using modern theory and empirical methods.

In the first part of the course we review the ways in which we can and cannot quantify the welfare of economic agents. We begin by reviewing the foundations of microeconomic theory which we use to analyze how the welfare of economic agents is altered due to exogenous changes in prices and/or income. Using these welfare measures, in the second part of the course we examine how public policies affect the welfare of economic agents using tools from public finance. Since our ultimate goal is applying welfare theory to empirical questions we will also review in part the empirical methods and tools required for conducting state of the art research in this area.

PROPOSED START: SU2017

**ENTR 820**

Corporate Innovation Strategies and Entrepreneurial Methods

**CORP INNV STRATGS (3)**

This course is designed to survey and explore the methods used to foster innovation and entrepreneurship in a corporate setting. Emphasis will be placed on the methods used in organizations to foster creativity, innovation, and new venture creation. This course covers both tactical and strategic approaches to innovation and entrepreneurship, and examines these in multiple contexts, including technology, business process, product, and strategy. Furthermore, the course will expand on widely accepted frameworks and perspectives for managing innovation, such as agile product development, and the lean startup approach. Students will also delve into the more abstract notion of how to create and enable an organizational culture of innovation, manage conflict, and negotiate agreements effectively. Lastly, a final objective of the class is to ensure students understand how to protect and manage intellectual property.

PROPOSED START: FA2017

**HDFS 538**

Dynamical Systems Methods and Applications

**DYNAMICAL SYSTEMS (3)**

The course will provide an overview of the concepts and theory behind dynamical systems, including techniques that are amenable to nonlinear dynamics. HDFS students can take this course to fulfill one of their methodology elective requirements. Both theoretical ideas and practical applications will be covered. The course will (1) survey a selection of dynamical systems concepts; (2) highlight general issues regarding the link between theoretical formulations of change concepts in dynamical systems terms and the design of empirical studies to test these concepts; (3) provide step-by-step instructions on data manipulation, graphing, and fitting of dynamical systems models; and (4) develop student’s skill in effectively communicating results from model fitting.

Emphasis will be placed on methods for fitting dynamical systems models to intensive longitudinal data, such as those available from diary, experience sampling, and ecological momentary assessment studies; some coverage of dynamical systems methods suited for panel data will also be included.

This course builds on courses in the HDFS required methodology sequence. Therefore, students are expected to begin this course with skills in regression techniques and multivariate data analysis before taking this course. Prior experience or coursework in mixed effects modeling and/or structural equation
modeling is helpful but not required. Students are encouraged to bring research issues and data pertinent to their own interests to class for discussion and critique.

In addition to building a conceptual and analytic understanding of dynamical systems, we will also develop hands-on familiarity with different types of dynamical systems by using software programs to simulate, fit, and assess results from fitting different dynamical systems models. We will use these software programs to build an understanding of different types of dynamical systems that might occur in behavioral sciences. We will draw on several benchmark dynamical systems as well as a variety of examples of dynamical systems from developmental research, family studies, and intervention science to give the student some perspective on when Dynamical Systems techniques might be useful. Practical methods for exploring linear and nonlinear relations in multivariate (intensive or panel) longitudinal data will be presented. Examples may include difference and differential equation models, growth mixture models, mixture dynamic structural equation models, regime-switching difference/differential equation models, and catastrophe models. Students will also learn to use several software packages to perform dynamical systems analyses on real (preferably their own) data sets.

PROPOSED START: SU2017

INTAF 510
Cross Cultural Conflict Resolution
CRS CULTR CON RES (3)
Across the globe there are more laws and provisions in place to protect human beings from discrimination than at any other time in history and yet there are more incidents of conflict, intolerance, bias, and violence than ever. How are we to make sense of these two competing realities? How can we become ethical leaders in the face of such contrasts and complications?

This course combines perspectives from communications, psychology, sociology, political science, law and legal studies, human rights, identity-based studies, media studies, and cultural studies to engage questions of how cultural difference and discrimination play a role in conflict and resolution.

Topics to be covered are 1) how societies create inequalitarian categories of identity, 2) how those divisions create conflict, and 3) how those divisions hinder conflict resolution. The course will look at a variety of ways that societies come to categorize forms of human life according to religion, nationalism, patriarchy, ethnic identity, and other forms of social division and stereotyping. One key area we will address is the development of law and other instruments that both protect and disenfranchise vulnerable populations. We will also look at strategies for cross-cultural community development and peace building. The topics will be studied in a cross-cultural context allowing students to consider these issues from a range of global perspectives.

PROPOSED START: SU2017

PHS 557
Global Impact of Infectious Diseases
GLOBL INF DISEASES(3)
This course is designed to provide an understanding of the global and local perspectives of infectious disease. This course will provide a fundamental knowledge of several different infections including virus, bacterial, and parasitic types. The course will then expand on this knowledge and discuss the impact of these infectious diseases on the global community, then discuss, analyze, and design methods for prevention and control. Diseases of global importance will include: malaria, HIV, hepatitis, dengue, emerging viral hemorrhagic fevers, causes of diarrheal illness, tuberculosis, polio, smallpox, cholera, syphilis, select parasitic diseases, and other diseases as necessitated by current global disease trends.

PROPOSED START: SU2017
OLD

ANTH 509
Research Design in Anthropological Fieldwork
RES DESIGN ANTHROP (1)
A survey of research design, sampling strategies, potential biases, confounding problems, and the limits of inference in anthropological fieldwork.
EFFECTIVE START: SU1990

NEW

ANTH 509
Proposal Writing
PROPOSAL WRITING (3)
This course provides practical training and experience in proposal writing and revisions for graduate students in anthropology and related disciplines.
PROPOSED START: SU2017

OLD

BA 501
Management
MANGEMENT (2)
Examination and application of concepts of human behavior and organization to managing people in work organizations.
EFFECTIVE START: SP2002

NEW

BA 801
Management
MANGEMENT (2)
This course is concerned with understanding and managing the behavior of people in organizations. The course will provide exposure to many of the concepts and skills that will help students become a more effective manager and organizational leader. This course includes tools that help students diagnose, understand, and develop solutions to management problems. The course will draw upon both the academic and practitioner literature to understand many facets of organizations and of the thoughts, feelings, and actions of people who work in them. It will focus on: 1) developing students’ conceptual understanding of issues involved in managing people; 2) providing opportunities for direct or vicarious learning of managerial skills that have been identified by practicing managers as being most important to their performance; 3) giving students insight into their own attitudes, beliefs, and management philosophy; 4) creating a forum for discussing management issues with colleagues.

OLD

BA 511
Financial Accounting
FIN ACCT (1-3)
Basic concepts and principles (i.e. the jargon) underlying financial accounting practices.
EFFECTIVE START: FA2008
Business enterprises convey information to their present and potential investors and creditors through financial reports. This course focuses on these financial reports, the data they contain, how users should read and interpret financial statements, and how users can incorporate this information into their investment decision making. It also examines how managers attempt to window dress these financial statements and how the numbers might affect managerial behavior.

PROPOSED START: SU2017

This course is designed to meet the entry statistical requirements for any course in the Smeal M.B.A. Program, as well as to provide job applicable skills across the entire business portfolio.

PROPOSED START: SU2017

Foundations in Management Accounting has two broad aims. First, it is designed to help students grasp the technical aspects of accounting for activities and processes within and between firms. Therefore, students will study methods of a) cost classification & estimation; b) cost measurement & allocation; c) profit planning; and d) evaluation and control of behavior. Second, the course emphasizes the context of managerial accounting. The firm suspends market prices that regulate behavior impersonally. Students will study how economic arrangements are organized in such non-market settings. Unlike financial accounting, the field of management accounting integrates notions from diverse fields including economics and sociology. Crucially, management accounting is situational and therefore requires and hones students' facility in both quantitative analyses and qualitative judgments.
Graduate Council  
Program, Option, or Minor Proposal Form

Submit 1 original, signed Graduate Council proposal form and 2 hardcopies of the graduate program proposal document, with a copy of the signed proposal form attached to each proposal copy, to the Office of the Dean of the Graduate School, 211 Kern Building, University Park. For more information about the process, see the Overview of the Graduate Council Curricular Review Process.

The Program Proposal Procedures provide guidance for the development of a graduate program proposal. If you have questions regarding the preparation of a graduate program proposal or how to complete this Graduate Council proposal form, contact the Office of the Dean of the Graduate School.

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Submitted by Graduate Program Head

Karen A. Thole  
Printed name  
Signature  
Date: 12/12/2016

Noted by College/School Representative to Graduate Council Subcommittee on New and Revised Programs and Courses:

Matt Parkinson  
Printed name  
Signature  
Date: 12/15/16

Approved by College/School Dean/Chancellor (or Designee):

Peter Bouver  
Printed name  
Signature  
Date: 12/17/16
Recommended by Chair, Graduate Council Subcommittee on New and Revised Programs and Courses:

On Behalf of John Challis
Printed name
Signature
Date: 3/7/2017

Recommended by Chair, Graduate Council Committee on Programs and Courses:

On Behalf of M. Kathleen Heid
Printed name
Signature
Date: 3/7/2017

Noted by Dean of the Graduate School:

On Behalf of Regina Vasilatos-Younken
Printed name
Signature
Date: 3/7/2017
Proposal for
A new graduate program in Additive Manufacturing and Design offering
Resident Master’s of Science and Online Master’s of Engineering Degrees

Units:
College of Engineering: Industrial and Manufacturing Engineering; Engineering Science and Mechanics; Mechanical and Nuclear Engineering; School of Engineering Design, Technology and Professional Programs

College of Earth and Mineral Science: Material Science and Engineering

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December 16, 2016
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Proposal for
Residential Master of Science in Additive Manufacturing and Design
and
Online Master of Engineering in Additive Manufacturing and Design

A. Introductory Narrative

This proposal seeks approval to establish a new graduate program in Additive Manufacturing and Design to be delivered for in-resident students at University Park, who will earn a Master’s of Science degree, and for online students, who will earn a Master’s of Engineering degree delivered through World Campus. The proposed are inter-departmental degree programs in the College of Engineering with inclusion of the Material Science and Engineering Department in the College of Earth and Mineral Science. The academic and administrative homes are in the Mechanical and Nuclear Engineering Department.

Additive manufacturing (also known as 3D printing) is redefining how components are designed, manufactured, and certified. Building three-dimensional parts layer-by-layer using additive manufacturing gives engineers unprecedented design freedom to create light weight structures, consolidate assemblies of components into a single 3D printed part, and functionally grade structures to improve performance. This is generating considerable interest in a wide range of industries, including aerospace, consumer goods, energy, medical, oil and gas, and space.

The 3D-printing technology itself enables production of parts that were otherwise too expensive or even impossible to make, while allowing multi-material parts to be designed and created with relative ease. The time required for design–build–test iterations can be significantly decreased for large systems composed of multiple components through the integration of 3D printing into product development strategies. Finally, new methods for qualifying processes and certifying parts for aviation, aerospace, medical, and other regulated industries are being developed since anyone with a 3D printer can now print any part for which they have a 3D computer model.

Non-destructive inspection technologies are facilitating this qualification and certification process, but these technologies are also opening up new avenues for reverse engineering products and devices and potentially infringing on patents and intellectual property. The legal and ethical implications of additive manufacturing are not well defined and are confusing as 3D-scanning technology becomes less expensive and easier to use, and the implications on policy and regulatory practices are undergoing scrutiny like never before.

Even though 3D printing is decades old, recent advances in additive manufacturing technology now enable manufacturers to produce end-use parts out of plastic as well as metallic materials. Ceramics, electronics, and organic tissue are also being 3D printed and challenging existing manufacturing paradigms. Designing parts to take full advantage of the freedoms that additive manufacturing allows requires an in-depth understanding beyond that learned in a single “Introduction to 3D Printing” course. Meanwhile, the intricacies of each of the currently seven additive manufacturing processes (e.g., material extrusion, powder fed fusion, directed energy deposition, etc.) create their own unique challenges when used in a real production environment. Inspecting, qualifying, and certifying parts made using additive manufacturing may be easier
thanks to advances in non-destructive inspection technologies, but manufacturers face new challenges ensuring parts meet the requisite design specifications and mechanical properties given the lack of standards and guidelines for tolerancing and design specification. The potential for additive manufacturing is tremendous, but the process, including both manufacturing as well as design, is not as easy as it looks or as portrayed to the general public.

The College of Engineering and College of Earth and Mineral Science at Penn State are uniquely positioned to educate the next generation of designers, engineers, and manufacturers as well as help retrain the existing workforce in all aspects of additive manufacturing and design. These Colleges already offer an extensive set of courses in additive manufacturing beyond the introductory course and have extensive expertise in all pertinent areas of additive manufacturing: planning, design, engineering, materials science, manufacturing and production, quality control, and inspection.

The proposed Master of Science (MS) and Master of Engineering (MEng) Degree Programs in Additive Manufacturing and Design will leverage these strengths at Penn State to create the first graduate program of its kind in the United States and satisfy a strong demand from numerous industries ramping up their production capabilities—and corresponding workforce—in additive manufacturing. The program will integrate graduate coursework across multiple Departments and Colleges at Penn State and provide unique hands-on experiences for both resident and online students in all aspects of the additive manufacturing process. Courses will be offered online as well as in-residence to target the widest possible audience. All students enrolled in the program, whether resident or online, will be required to spend time on site, working in Penn State’s state-of-the-art additive manufacturing laboratory, CIMP-3D, the Center for Innovative Materials Processing through Direct Digital Deposition (www.cimp-3d.org).

In developing the proposed MS and MEng in Additive Manufacturing and Design, numerous meetings were held with both internal and external constituencies. A series of planning meetings was held with Penn State faculty from each of the departments, colleges, and facilities involved to determine interest levels and potential course offerings. There was strong interest expressed from those faculty teaching the relevant courses. Graduate students who are currently doing research in the additive manufacturing area also expressed strong interest in having such a degree program at Penn State. Finally, members from the Industrial and Professional Advisory Councils (IPAC) of Engineering Science and Mechanics, Industrial and Manufacturing Engineering, Material Science and Engineering, Mechanical and Nuclear Engineering, and the School of Engineering Design, Technology, and Professional Programs met to discuss the proposed MS and MEng programs. All expressed strong support with various suggestions about the program and on site laboratory experience, which we have incorporated into this proposal.

The proposed graduate program is specifically aimed toward industry to create a new cadre of engineers and help retrain the existing engineering workforce to take full advantage of what additive manufacturing has to offer. Students, who are enrolled in the one-year MS program and are coming directly from their undergraduate programs, will be encouraged to participate in internships with industry partners to help them advance the utilization and practice of additive manufacturing. This hands-on experience in industry will culminate in an MS or MEng paper to satisfy a portion the degree requirements. We also envision that these internships will assist
students enrolled in the program to find meaningful positions upon completion of the degree. Many industry members have commented on the shortcomings of the current workforce with the requisite skills and knowledge to utilize additive manufacturing to its fullest. To address these shortcomings, for MS degrees, the culminating experience will be a paper derived from 3 distributed credits under which fundamental theory is applied to develop new knowledge and processes relevant to advances in additive manufacturing. For M Eng degrees, students will take a 3-credit course at the end and develop a culminating paper that focuses on practical applications in the additive manufacturing workplace.

B. Program Statement

1. Degree Requirements

The proposed Master of Science in Additive Manufacturing and Design (MSAMD) and Master of Engineering in Additive Manufacturing and Design (MEngAMD) degrees are 30-credit degree programs that are offered resident, in the case of the MSAMD, and online, in the case of the MEngAMD, to graduate students to provide the analytical and practical skills required to digitally design, develop, analyze, numerically model, optimize, fabricate, and inspect new components and subassemblies using appropriate additive manufacturing technologies. This requires knowledge across multiple domains, including industrial engineering, mechanical engineering, engineering design, engineering science, and materials science.

In the first semester of their degree program whether it be the MSAMD or the MEngAMD, an academic adviser will be assigned. All MSAMD and MEngAMD students will be required to enroll in five core, required courses that cover additive manufacturing processes (4 credits), materials for additive manufacturing (4 credits), the engineering and scientific foundations of additive manufacturing (4 credits), design for additive manufacturing (4 credits), and a hands-on laboratory experience in additive manufacturing (3 credits). The 4 credit course options enable students to get more depth in a single course, which is particularly advantageous to those taking online courses. This gives instructors the flexibility to develop 3 credit courses with complementary 1 credit lab, which online students could do in their company, at home, or come to campus. This also provides the departments with flexibility in instructor assignment and course development as two faculty can split development and instruction of a 4 credit course and focus on metals (for 2 credits) and plastics (for 2 credits) within a single course, for example. Finally, the 4 credit course offerings are commensurate with Supply Chain’s online Masters program offerings, for which we have already developed 3 courses.

In addition to the core courses, students will be required to enroll in electives (8 credits) that include design, materials, manufacturing, technical writing, technical presentations, and supply chain. The students will be required to enroll in a seminar course (1 credit, not counted toward the degree). To meet the degree requirements, students will be required to complete a culminating project that leads to a paper, which will be worth three (3) credits. To distinguish the MSAMD, the students will be required to enroll in research (1 credit) each of three semesters to account for the three (3) credits. Alternatively, the MEngAMD students will enroll in a single course (3 credits) in one semester in order to complete their required paper. The resident students will be encouraged to take part in an internship in industry during the degree program. Assistance will be provided to the students in finding suitable internships.
Resident and online students will be required to be in-residence at Penn State for two 3-day
d periods to take place during the start and the end of the summer semester (for a total of 45 hours,
or 3 credits) for a structured additive manufacturing laboratory course. The laboratory course
will involve the use of the facilities in CIMP-3D as well as the Material Characterization
Laboratory (MCL) in the Millennium Sciences Complex and the Factory for Advanced
Manufacturing Education (FAME) in Industrial and Manufacturing Engineering. CIMP-3D
already offers week-long short courses for industry and government employees, thereby
demonstrating that this is possible and highly desired by companies without access to state-of-
the-art additive manufacturing technology and non-destructive inspection equipment.

All students will be required to complete their program with a culminating project (3 credits) in
which the requirement will be a final paper that is reviewed by their assigned academic adviser,
who will be on the graduate faculty in one of five departments previously mentioned: (1)
Engineering Science and Mechanics, (2) Industrial and Manufacturing Engineering, (3) Material
Science and Engineering, (4) Mechanical and Nuclear Engineering, and (5) School of
Engineering Design, Technology, and Professional Programs. The final paper requirements,
further described in Appendix B, must demonstrate the student’s depth of knowledge in the field
of additive manufacturing and design. As an option, the culminating project may be completed
either through an industrial internship (for resident students) or at their current place of
employment (for online students). The choice of their project topic will be mutually determined
by the student and his/her adviser and take into consideration that an M Eng paper focuses on
practical applications in the workplace, while the MS paper focuses on integrating various
fundamental concepts into new knowledge or processes. It is important to note that the MS
paper will be completed through three semesters of research on campus in which the students
must register for one credit during each of the three semesters. The MS paper is expected to
contribute to a better fundamental understanding of the additive manufacturing process and
design. The MEng paper will be completed during only one semester while the student will be
off-campus. The MEng paper is expected to contribute to the application of additive
manufacturing in terms of the development of new products. The written paper based on the
project must contain a project description, literature review, results, analysis, and interpretation
of its findings as further described in Appendix B. For the MSAMD students who require more
time beyond one year to complete the final paper will be allowed to complete the paper and have
it reviewed and approved after the third semester has ended. Students are not required to remain
in residence while they complete the final paper. However, extensions granted to students in this
program must comply with the Graduate Council policy on deferred grades.

Students will be encouraged to publish their project work in peer-reviewed journals, trade
journals, conference proceedings, or as confidential company reports, depending on the nature of
the project and implications of its findings.

All students will be encouraged to complete an internship in industry, in a federal laboratory, or
at Penn State (e.g., in CIMP-3D) in which they gain practical experience in additive
manufacturing and/or design for additive manufacturing. While this will most likely occur in
their place of employment for the online students, the resident students will be assisted in finding
an internship. An Industry Advisory Board will be formed to help guide the overall program and
assist in the internship program. Members of the advisory board will be expected to offer
internship positions to the MSAMD and MEngAMD students. It is expected that most
MEngAMD students, however, will be professionals already working in industry. Although the internship will be strongly encouraged, it will not be required to obtain the degree.

The MSAMD and MEngAMD Programs are intentionally structured such that additional course options and electives can be added at a later date through program revision. The core courses have been chosen to be relevant to additive manufacturing regardless of the application domain with future program expansion in mind. In addition, we are proposing to take advantage of several courses that are already offered online in the College of Engineering and College of Earth and Mineral Science.

The requirements for the proposed MSAMD and MEngAMD degrees are:

1. A minimum of 30 credits at the 400, 500, or 800 level is required. For the M.S., at least 18 credits must be in 500-level courses. For the M.Eng., at least 18 credits must be at the 500 or 800 level, with a minimum of 6 credits at the 500 level.

2. Completion of five required courses that total 19 credits with a grade point average of 3.00 or higher. The 5 required courses are EDSGN 562 (4 credits), E SC 545 (4 credits), IE 527 (4 credits), MatSE 567 (4 credits), and ME 566 (3 credits).

3. A minimum of at least 8 credits in 400- and/or 500-level courses offered with the following designations: EDSGN, E SC, IE, MATSE, or ME. Note that EDSGN 596, E SC 596, IE 596, MATSE 596, and ME 596 cannot be used to fulfill this requirement.

4. Completion of 3 credits in one of the following offerings to complete the culminating project: EDSGN 596, E SC 596, IE 596, MATSE 596, or ME 596. MSAMD students will be required to complete one (1) credit in each of three (3) semesters while MEngAMD students can complete a three (3) credit course in one (1) semester.

5. A scholarly paper must be completed to meet the specific requirement of the culminating experience. This paper will demonstrate depth of knowledge to his/her adviser, a second reader, and the Director of Graduate Studies in one of the five aforementioned departments.

6. All students must successfully complete one credit of colloquium preferably in their first two semesters in the program. The one-credit colloquium does not count toward the 30 graduate course credits in Requirement 1 above. The following courses are offered to meet this requirement: EDSGN 590, E SC 514, IE 590, MATSE 590, and ME 590.

7. All students will be required to complete SARI (Scholarship and Research Integrity) training.

**CULMINATING EXPERIENCE - MSAMD and MEngAMD PAPERS**

The candidate registers for 30 course credits of which 19 credits must be the five required courses at the 500 level. A maximum of three credits of EDSGN 596, E SC 596, IE 596, MATSE 596 or ME 596 can be counted in the total of 30 credits for students completing their project and MS paper.
Candidates must write a culminating project paper on a topic mutually agreed upon with the adviser. Students will be encouraged to utilize an industry internship (resident students) or current employer (online students) to identify a relevant or practical problem of importance that additive manufacturing and appropriate design methods could address. The quality of the required paper is such that it must be suitable for publication in a professional journal or proceedings at a national or international conference, which generally requires a peer-review process, as described in the guidelines provided in Appendix B. These guidelines indicate each paper submission must contain sections that fully describe a relevant survey of past literature pertinent to the research; a clear description of the methods used to determine the research results given in the paper; comprehensive analyses of the results in the context of the research topic as well as relative to past studies; and, finally, a synthesis of the results that is concisely summarized. Given all of our graduate faculty are active reviewers of conference proceedings and archival journals, the faculty are well-qualified to rigorously review the research paper presented by the online students.

The colloquium is a one-semester, one-credit requirement for all incoming graduate students, which does not count towards the 30-credit requirement. Resident and online students may enroll in suitable colloquia in EDSGN 590, ESC 514, IE 590, MATSE 590, or ME 590. In the seminars, presenters are experts in the field primarily from outside of Penn State representing industry, government, and academia. Included in these lectures are ethics discussions that meet the Scholastic and Research Integrity (SARI) requirements. The colloquia are video captured and made available for the online students. Attendance is monitored through the login to the website for the online students. As discussed later in this proposal, there are a number of advantages in having the online students enroll in one of the colloquia series. In particular, this helps ensure that online students: i) are educated in current research trends, which is important for an MEngAMD degree; ii) identify with Penn State as their institution; iii) are able to participate in the SARI lectures; and iv) have an opportunity to interact with their student colleagues in the program.

The online program will be identical to the resident program. The program will not be cohort based and, as such, permits students to enter or graduate when appropriate. The courses that will be offered are the same as those that we will be offering to our in-resident students, which are all taught by graduate faculty who are either tenure-track or tenured.1

3. Formal Graduate Bulletin Statement
The formal Graduate Bulletin Statement is included in Appendix A.

C. Admission Requirements
To maintain a high quality program, it is important that our students are of a caliber to succeed. As such, the admission requirements for the students enrolling in the MSAMD and MEngAMD degree programs will be based on: academic records, GRE scores, applicable work experience, their personal statement of interests in additive manufacturing design, and three letters of recommendation from a previous professor or supervisor who can attest to the applicant’s

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1 On occasion, the associated Departments hire instructors from the Applied Research Lab to teach courses. The hired instructors all have graduate faculty status, which is overseen by the Department Heads and by the Department’s Promotion and Tenure Committee, in the relevant programs.
academic potential. Applicants will be expected to have a Bachelor of Science or four-year Associate’s degree from an accredited institution in engineering, engineering technology, manufacturing, materials science, or related field. An undergraduate cumulative grade point average of 3.0 or better on a 4.0 scale in the final two years of undergraduate studies is required.

Each application will be closely reviewed by a MSAMD and MEngAMD Admission Committee made up of one faculty member from each of the five participating departments: (1) Engineering Science and Mechanics, (2) Industrial and Manufacturing Engineering, (3) Material Science and Engineering, (4) Mechanical and Nuclear Engineering, and (5) School of Engineering Design, Technology, and Professional Programs. The faculty member who will serve on the MSAMD Admission Committee will be nominated by the respective Department (or School) Head.

The language of instruction at Penn State is English. International applicants must take and submit scores for the TOEFL (Test of English as a Foreign Language) with the exceptions noted below. The minimum acceptable score for the TOEFL is 80 or higher on the internet-based test with a 19 or higher in the speaking section. An acceptable alternative to the TOEFL, which will be accepted, is the International English Language Testing System (IELTS) test, on which a minimum composite score of 6.5 will be required. International applicants are exempt from the TOEFL requirement if they have received a baccalaureate or graduate degree from a college/university/institution in any of the following: Australia, Belize, British Caribbean and British West Indies, Canada (except Quebec), England, Guyana, Republic of Ireland, New Zealand, Northern Ireland, Scotland, the United States and Wales.

D. Justification Statement

1. Program Goals

The program goals are to educate a new cadre of graduate students and train engineers and manufacturers in the existing workforce to apply a multidisciplinary approach to utilize additive manufacturing and associated design methods and tools effectively. This educational approach will allow those completing the MSAMD and MEngAMD degrees to develop new design methods and paradigms that will shorten product development cycles and manufacturing lead times; exploit the uses of the “digital thread” during product development; be educated on all the technical and ethical issues associated with 3D printing; and to perform detailed analyses of the additive manufacturing processes.

2. Needs Assessment

Manufacturers across a broad spectrum of industries, including automotive, aerospace, dental, discrete, high tech, and medical products, are all actively piloting and using 3D printing technologies today, according to a 2015 Forbes.com report. According to a report from Wohlers Associates, a company that provides technical and strategic consulting for manufacturing firms, revenues from additive manufacturing will exceed $21B by 2020, up from just over $3B in 2013. The report goes on to suggest a factor will be the expanded use of technology for producing of parts, especially in metal that go into final products. As a result of advances in additive manufacturing, in particular, industry experts expect an increase in demand for workers with additive manufacturing related skills and education. In a March 2015 article by U.S. News and
World Report, *dedicated programs are scarce with most schools only offering research opportunities at the graduate level.*

In summary, the motivation for adding the MSAMD and MEngAMD degrees to the portfolio of offerings at Penn State are twofold: i) to meet the needs expressed by industry and the current engineering students on the offering of a non-existent degree program that will be offered both in residence and online; and ii) to react to a quickly growing industry that is expected to impact the economy and drive industrial competitiveness in Pennsylvania, the United States, and beyond.

There is an increased demand for advanced technical degrees by both newly graduated engineering students as well as practicing engineers. It is predicted that, over the next ten years, 3.5 million manufacturing jobs will become available.\(^2\) Moreover, in the last ten years, undergraduate engineering enrollments in the U.S. have increased from 400,000 to 620,000.\(^3\) For example, mechanical engineers (MEs) number as the fourth largest engineering occupation with about 240,000 employed in the United States. About half of those MEs are employed in the professional, scientific, and technical services sector.\(^4\) Because many of these MEs are working in highly technical fields, it is of interest to offer a technically strong degree program. The proposed program will present online students with the opportunity to gain technical depth in additive manufacturing and design, which was not available when they completed their undergraduate degrees.

Currently, there are seven federally-funded manufacturing institutes in the United States; the first was the National Additive Manufacturing Innovation Institute, now called America Makes (https://americamakes.us/). Penn State was a founding partner in America Makes, which is focused on additive manufacturing technologies. While America Makes offers numerous educational programs, there currently exist no full degree programs.

3. **Program Objectives**

The overall goal of the MSAMD and MEngAMD Programs is to educate students and working engineers to become technically outstanding experts in additive manufacturing. Specifically, the objectives include:

1. Apply foundational knowledge, critical thinking, problem solving, and creativity in the uses of additive manufacturing and associated design tools and methods.
2. Grow as leaders in manufacturing while maintaining the highest ethical standards in applying additive manufacturing to industry-relevant problems and design challenges.
3. Strive for the advancement of the state-of-art in additive manufacturing and design technologies.
4. Develop innovative solutions through new design paradigms in their respective industries. It is recognized that Masters-level study leads to the development of in-depth knowledge of an engineering discipline. This knowledge may include advanced\(^5\) fundamental theory, hands-on

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\(^2\) http://www.sme.org/

\(^3\) http://www.asee.org/

\(^4\) Penn State’s World Campus, “Environmental Scan: Market for an Online Master’s Degree in Mechanical Engineering,” 2011.

\(^5\) Here and in the learning objective the word, advanced, is intended to indicate that this understanding should be beyond that of a BS degree.
practice in design and research, or complex problem solving through applications of mathematics, science and engineering. At Penn State, we offer Master’s of Science (MS) and Master’s of Engineering (MEng) degrees. The MS and MEng have equal rigor but distinct educational goals as defined by the Graduate School.

The MS is an academic degree, which is “strongly oriented towards research and the creation of new knowledge” whereas MEng is a professional degree, which “emphasizes practical application of knowledge for solving problems”. Both the MS and MEng degrees require a culminating experience in which students demonstrate the ability to analyze and synthesize information within their field of study.

The culminating experience for an MS degree may be research conducted under the supervision of a faculty mentor, an independent study experience completed under the direction of a faculty member, or a course-based culminating experience. Regardless of the type of culminating experience, the MS degree requires that the writing of a thesis or a scholarly paper. For an MEng degree, the culminating experience may include a project, an internship, or other similar experience, or writing of a paper on a topic that has relevance to professional practice. The specific nature of the culminating experience is determined by the faculty responsible for offering the degree program. The proposed program offers two different tracks: MS and MEng with the differentiation being that previously described.

4. Program Size and Duration

The MSAMD Program is expected to accept 10 new students each year and the MEngAMD Program is expected to accept an estimated 20 online students. It is expected that the resident students will complete their degree in one year. For the online students, it is expected that it will require approximately three years to complete their degrees (~3 courses per year). As such, it is expected that a maximum of 100 students will be enrolled in the program during any one year.

5. Proposed Course Offerings and Schedule

An overview of the thirty (30) credit program of study includes:
- nineteen (19) credits of formal course work in five required courses (4 credits each in IE, EDSGN, E SC, MATSE for depth; and 3 credits in ME that involve a practical, hands-on laboratory component);
- eight (8) credits of design, materials, manufacturing, technical writing, technical speaking, and supply chain electives (for breadth and depth); and
- three (3) credits for a paper (for an individual project based on culminating project).

The 19 credits of required courses include:
E SC 545 (J. Todd) Engineering and science of additive manufacturing, including laser-based interactions, modeling and simulation, in situ process monitoring sensing technologies (4 credits);

6 This estimate is based on interest levels expressed by GE, Lockheed Martin, LORD Corporation, and NAVAIR, among others.
IE 527 (S. Joshi): Digital workflow for additive manufacturing, reverse engineering, overview of additive manufacturing processes for metals and polymers, applications and case studies (4 credits);  
EDSGN 562 (N. Meisel) Design for additive manufacturing, topology optimization, lattice structures, multi-material analysis and design (4 credits);  
MatSE 567 (A. Beese) Critical considerations for additive manufacturing of metals, focusing on processing structure-property relationships. (4 credits);  
ME 566 (T. Simpson) Hands-on additive manufacturing lab with powder bed fusion, directed energy, non-destructive inspection (3 credits)  
In addition, there are eight (8) credits of electives required in design, materials, and manufacturing. There are already numerous electives available both online and in resident from the five aforementioned departments.

For the first three years, the table below describes the schedule for the five required course offerings. Each of the fall and spring semesters the graduate colloquium courses will be offered online and in residence. In each of the fall, spring, and summer semesters the culminating project course will also be offered. It is expected that beyond the first three years, the five required course offerings will be repeated according to the schedule for the 2019/2020 academic year. In addition to these five required course offerings, there is a wide variety of online courses that can meet the electives requirement for both the resident and online students. It is expected that the number of electives will grow given the new faculty who are being hired at Penn State.

<table>
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<tr>
<th>Offering Schedule for Five Required Course</th>
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<td>ESC 545</td>
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<td>IE 527</td>
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<td>MatSE 567</td>
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<td>EDSGN 567</td>
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<td>ME 566</td>
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6. How the Program Strengthens Penn State

Penn State is well-positioned to lead the first-of-its-kind degree program in additive manufacturing and design for many reasons. First, Penn State has significant depth of expertise in additive manufacturing and design in the College of Engineering (Engineering Science and Mechanics; Industrial and Manufacturing Engineering; School of Engineering Design, Technology, and Professional Programs; and Mechanical and Nuclear Engineering); the College of Earth and Mineral Science (Materials Science and Engineering); Smeal College of Business (Supply Chain and Information Systems); and the Applied Research Laboratory. Many of the faculty in these departments are strong collaborators through the Center for Innovative Materials Processing through Direct Digital Deposition (CIMP-3D), which maintains a research portfolio of approximately $8M per year in additive manufacturing, including design, materials, process sensing, qualification/certification, etc. Second, there is significant interest and support for 3D printing across Penn State.
At the University level, 3D printing is becoming increasingly important to driving economic development and ensuring a sustainable future. The University’s thematic priority of Driving Digital Innovation states that Penn State will be a leader in making sure our students are prepared for the digital age to foster economic growth. Entrepreneurial opportunities in 3D printing and additive manufacturing abound, both in using the technology to foster entrepreneurship as well as driving innovation within additive manufacturing (e.g., spinning out software related to additive manufacturing and design, new start-ups related to additive manufacturing technology). Thus, the proposed program aligns well with President Barron’s Invent Penn State initiatives as 3D printing and additive manufacturing serve as a key innovation asset to the University.

In the College of Engineering and aforementioned departments, one of the research thrusts from the 2015–2020 Strategic Plan is Advanced Manufacturing for Medical, Electronic, and Mechanical Sciences, which will advance manufacturing technology, in general, and 3D printing, in particular. In concert with the College of Engineering, the Mechanical and Nuclear Engineering, Engineering Science and Mechanics, and Industrial and Manufacturing Engineering Departments have included additive manufacturing as key areas in their strategic plans, and multiple new faculty hires have occurred within the College of Engineering in areas related to additive manufacturing.

The proposed MSAMD and MEngAMD degree programs also provide an ideal platform for continued growth in response to the many areas in which 3D printing is quickly evolving: bioprinting, hybrid manufacturing, the internet of things, and many others.

7. Impact on Existing Programs and Faculty Load

As was previously mentioned, the MSAMD will be offered as both a one-year MS degree program for resident students and the MEngAMD degree program for online students, most of whom will be working in industry. Given the degree program will be shared among five units in two Colleges and will involve courses that would apply to existing MS degree programs in their respective disciplines, it is expected that the impact on the faculty workloads in any single department to be minimal. The four departments and one school include: (1) Engineering Science and Mechanics, (2) Industrial and Manufacturing Engineering, (3) Material Science and Engineering, (4) Mechanical and Nuclear Engineering, and (5) School of Engineering Design, Technology, and Professional Programs.

### Faculty Teaching Five Required Courses

<table>
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<th>Faculty</th>
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<tr>
<td>Tim Simpson</td>
<td>Professor of Mechanical Engineering and Industrial Engineering</td>
</tr>
<tr>
<td>Nick Meisel</td>
<td>Assistant Professor of Engineering Design and Mechanical Engineering</td>
</tr>
<tr>
<td>Judith Todd</td>
<td>Professor and Department Head of Engineering Science and Mechanics</td>
</tr>
<tr>
<td>Allison Beese</td>
<td>Assistant Professor of Material Science and Engineering</td>
</tr>
<tr>
<td>Sanji Joshi</td>
<td>Professor of Industrial and Manufacturing Engineering</td>
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There is a strong emphasis on developing one-year MS programs at Penn State to serve a wider audience of students. Similar to many of Penn State’s peer institutions, it has been identified that there is a need to serve students who want to further their education in a specialized area.
The online degree will permit us to offer a wider range of courses for MNE’s on-campus MSME students. In-resident students will only be permitted to enroll in the on-campus versions of the online courses. Second, the degree program will allow us to enhance MNE’s current Master of Science in Mechanical Engineering course offerings since students will be permitted to enroll in the online mechanical engineering courses as technical electives. Third, the resources we expect to acquire through the offering of the online program will permit the associated departments to grow in graduate student support and in tenure/tenure-track faculty lines.

Another positive impact that the degree programs will have, albeit harder to quantify, is the added benefit of having the in-residence students enroll with practicing engineers in the same course, which will enrich the discussions for both our faculty and our students. We do expect that bridges will be strengthened between industry, government, and Penn State as the online students will bring their experiences into the classroom. In fact, we plan to leverage the projects performed by the students and papers written by the students in the program to help us identify new research directions, validate our analytical models and design tools, develop new industry partnership, and broaden the impact of Penn State’s research in additive manufacturing.

8. Units’ Ability to Offer a High-Quality Resident and On-Line Program

The MSAMD and MEngAMD degree programs will be administered through one Department, namely Mechanical and Nuclear Engineering.

All of the departments associated with this proposed effort offer strong, nationally ranked resident graduate programs. In addition, the Mechanical and Nuclear Engineering Department has two active online graduate programs: one is the MS in Mechanical Engineering and the other is an MEng in Nuclear Engineering. The enrollments in these two online programs include 45 MSME and 55 MEngNucE students. Note that the MSME online program was introduced in 2014 while the MEngNucE online degree was initiated approximately ten years ago.

In July 2016, the Department of Mechanical and Nuclear Engineering along with the support of Penn State’s World Campus invested in two non-tenure track individuals: Dr. Catherine Berdanier who holds a doctoral degree in Engineering Education from Purdue University and Dr. Robin Tate who holds a doctoral degree in Educational Psychology from Penn State. Both of these individuals are assisting the tenured/tenure-track faculty who are teaching graduate courses online and in resident with effective, state-of-the-art teaching methods as well as effective assessment methods. Their efforts are contributing to the existing Masters of Science in Mechanical Engineering online degree program in which those courses may also be used as technical electives for the proposed Masters of Science in Additive Manufacturing and Design degree program.

All of the Departments and School associated with the proposed MSAMD and MEngAMD programs have agreed to commit resources to hire two individuals: one instructional designer (this is in addition to the one already existing in the Mechanical and Nuclear Engineering Department) and one staff assistant. The instructional designer will assist all of the faculty in developing the five required courses as well as the continued growth of the elective courses. The staff assistant will track the students’ progress, track the associated data for the Program, and assist the online and resident students with any questions they have.
We propose to manage the MSAMD and MEngAMD in the Mechanical and Nuclear Engineering Department, and the online MEngAMD degree program will be executed through World Campus in the SAVE model.

9. Learning Objectives and Expected Student Accomplishments

The MS is an academic degree that is “strongly oriented towards research and the creation of new knowledge”. The degree requires a “significant culminating or capstone experience or other mechanism to demonstrate evidence of analytical ability and synthesis of material.”

Proposed MSAMD Learning Objectives:

A. Graduates will be able to demonstrate understanding of advanced core principles and methods from selected sub-fields of additive manufacturing and design at a depth consistent with their course of study.
B. Graduates will be able to apply their knowledge of and methods from selected sub-fields of additive manufacturing and design to formulate and solve engineering problems.
C. Graduates will be able to analyze and synthesize knowledge within the field of additive manufacturing and design to extend existing knowledge through a research experience or a course-based culminating experience.
D. Graduates will be able to demonstrate proficiency in oral and written communication appropriate to their discipline.
E. Graduates will be able to demonstrate an understanding of, and a commitment to, the standards for scholarship and research integrity within additive manufacturing and design.

The Master’s of Engineering (M Eng) is a professional degree that “emphasizes practical application of knowledge for solving problems”. “All MEng programs require a significant culminating or ‘capstone’ experience. Each program has established the specific manner for meeting the requirement, which may take the form of a paper, project, internship, or other similar experience serving to demonstrate comprehensive and in-depth knowledge of the practice of the field of study. The nature and extent of this work and when it is to be undertaken within the program of study shall be determined by the major program.”

Proposed MEngAMD Learning Objectives:

A. Graduates will be able to demonstrate understanding of advanced core principles and methods from selected sub-fields of additive manufacturing and design at a depth consistent with their course of study.
B. Graduates will be able to apply their knowledge of selected sub-fields of additive manufacturing and design to formulate and solve engineering problems.
C. Graduates will be able to analyze and synthesize knowledge within the field of additive manufacturing and design to address a complex problem with practical relevance.
D. Graduates will be able to demonstrate proficiency in oral and written communication appropriate to their discipline.
E. Graduates will be able to demonstrate an understanding of, and a commitment to, academic integrity and the standards for professional practice within additive manufacturing and design.
Graduates of the MSAMD and MEngAMD programs will be able to design and manufacture components using the latest additive manufacturing techniques for a wide range of applications including aerospace, energy, medical, transportation, chemical, food, health, and others. It is expected that the graduates will be effective in both large companies, many of which are embracing additive manufacturing for reducing product development times, and small companies, many of which are developing new products or processes that are too risky for larger companies to pursue.

10. Non-duplication of Other Degree Programs

As was stated, there are currently no graduate degree programs in additive manufacturing in the United States. And, not graduate degree programs in additive manufacturing are given at Penn State.

E. Essential Elements of Residency

To best meet the needs of working professionals, the MEngAMD program will be offered online through Penn State’s World Campus. The following items address the elements of residency that will be supported in the online environment.

1. Interaction Between Faculty and Students Beyond Direct Instruction

The interaction between faculty and students will take place through the courses and through the completion of their culminating project and paper to fulfill the degree requirements. During course offerings, the distance students will interact with the faculty during specified office hours either by phone or through web-conferencing such as that provided by Skype. In addition, discussion boards will be set up for all students to interact with the instructor as well as each other. All faculty will be provided cameras for their offices to assist with “face-to-face” interactions. In addition, students will interact directly with the faculty through email exchanges.

To complete the paper option, the online students will enroll in three (3) credits in one of the five special projects sections (EDSGN 596, E SC 596, IE 596, MATSE 596 or ME 596) which will count towards the thirty (30) credits. Through enrolling in one of these sections, they will be assisted by the Department of Mechanical and Nuclear Engineering (degree home department) in identifying a graduate faculty member with whom they will complete the culminating project needed for the paper. A website will be developed with project solicitations by the graduate faculty from which the student may elect to choose. Alternatively, the students will have the option of proposing a project to one of our graduate faculty for consideration. Faculty will be appropriately compensated for working with the online students on their particular research topic and associated paper.

2. Interaction Among Students

The MEngAMD online students will need to meet the same requirement maintained by our MSAMD resident students in attending a graduate colloquium. This is an important experience that will accomplish two important objectives: i) ensure the online students are educated in modern research topics; and ii) ensure the online students have opportunities to be engaged with resident students and faculty at Penn State.
Both the MEngAMD online and MSAMD resident students will be required to enroll in ME 566, which is a hands-on lab course that will take place on campus in CIMP-3D. During the lab, the on-line and resident students will work side-by-side in the lab, completing a set of design, fabrication, and testing exercises related to additive manufacturing. ME 566 will involve fabrication of both polymer and metallic components using the 3D printers and additive manufacturing systems in CIMP-3D, characterizing and inspection components in CIMP-3D and Penn State’s Materials Characterization Lab, and machining and post-processing components in the Factory for Advanced Manufacturing Education in Industrial & Manufacturing Engineering. The lab will provide an in depth hands-on experience that relates the theory and knowledge learned in their courses to practical implementation and application of additive manufacturing in a realistic environment.

The colloquium is a one-semester, one-credit requirement for all incoming graduate students, which does not count towards the thirty (30) credit requirement. The colloquium includes speakers from around the world who are experts in their research fields. Many are from highly respected institutions, while there are numerous other experts from industry and from government research laboratories. The colloquium will be captured and made available for the online students. Attendance will be monitored through the login to view the seminars.

In addition to the colloquium, course instructors bear primary responsibility for emphasizing a learning environment for the online students that fosters interactions among students. This type of learning environment is created and fostered through the assistance of an instructional designer and expert in engineering education, who were previously discussed.

3. Access to Information and Instructional Resources

Libraries

Penn State’s University Libraries provides a wealth of resources to the Penn State academic community including those students enrolled through World Campus programs. The Penn State’s library system is the 7th largest research library in North America with more than 100,000 e-books. As with the resident students, the online students enrolled in the MEngAMD degree program will have access to the library resources to access e-journals, e-books, course reserves and database searches, which will be helpful for their course work as well as for preparation of their research-based paper to meet the degree requirements.

In addition to the Library’s electronic copies of various materials, University Libraries provides access to interlibrary loan and document delivery materials in both hard copy and electronic format. Online students simply make a request for mail delivery of books and journal articles that are owned by any Penn State library location, as well as materials from other libraries through the Interlibrary Loan service. Articles not found in the Penn State Libraries may also be requested by using a document delivery service that is provided whereby articles are faxed or delivered in electronic format (PDF, for example).

Assistance can be requested from reference librarians via email, phone calls, or chat services. Also available are online library tutorials for student use to become acquainted with the many resources available.
4. Access to Suitable Academic Advising and Support Services

Academic Advising
Just as our in-resident students are advised, our online students will be advised by our respective graduate programs; and they will be advised by their assigned graduate faculty adviser on matters related to their paper. The Associate Department Head of Graduate Programs in the Department of Mechanical and Nuclear Engineering, along with the office staff members, will provide special assistance needed by the online students regarding their degree progression. The Associate Department Head will also closely monitor the course selections made by the online students to ensure the appropriate technical courses are taken. Advising for students in the online program will take place through a mutually agreeable combination of email, web/audio conferencing, telephone calls, and in-person meetings when appropriate. The assignment of their advisor will take place in the first semester of their study.

As with our in-resident students, the online students will need assistance with choosing a graduate faculty adviser to advise them when preparing the required research paper. To assist the students in choosing an adviser, a website will be maintained whereby research topics will be suggested by faculty who are seeking to advise the online students. The Graduate Faculty in each of the five Departments and School will directly advise the online students in completing the research projects. Alternatively, the online students may also propose a research topic and seek an adviser through the help of the Mechanical and Nuclear Engineering’s Graduate Studies Office. All faculty advisers will be assigned by the Mechanical and Nuclear Engineering’s Associate Department Head for Graduate Studies.

World Campus Admissions and Financial Aid
World Campus will typically be the first point of contact for prospective students for the online program. The Admissions staff will address questions from prospective students, and discuss financial aid options.

5. Students’ Contribution to the Program, College, and University

As was previously mentioned, the work experiences that the online students will bring into the classroom will be of benefit to our faculty and to our on-campus students. These contributions could lead to enhanced discussions as well as potential research collaborations.

6. Identification with Penn State

The students enrolling in the online MEngAMD degree program will identify with Penn State through several avenues:

i) enrolling in EDSGN/IE/MATSE/ME or 590 ESC 514 colloquium;
ii) interacting directly with the faculty through courses and office hours;
iii) being advised by a Penn State graduate adviser; and
iv) enrolling in the ME 566 laboratory as part of their program.

Discussion boards will be provided for interaction between the students (online and resident) as well as with the faculty. These discussion boards will be used as a vehicle to discuss topics as well as to post relevant material.
7. Exposure to and Socialization in the Field of Study

The students enrolling in both the online MEngAMD and resident MSAMMD degree programs will be socialized in the field of study through the colloquiums, as discussed in the previous section given experts from the field will provide seminars on the state-of-the-art of the field. Because the on-line and resident students are both enrolled in the courses, there will be great opportunities to interact with one another through course blogs, as one example. Finally, we expect that through the on-campus required laboratory course, the students will interact not only with each other but with Penn State experts who are overseeing the operation of the additive manufacturing equipment.

F. Program Operation and Maintenance

1. Program Coordination

The coordination for the MSAMMD and MEngAMD Programs will reside within the Mechanical and Nuclear Engineering Department at Penn State – University Park with the primary operations occurring within the MNE Graduate Office. Those below will be involved in administering the online program. Note that two positions are listed as open, but it is expected that these will be filled once the degree program has been approved.

Dr. Karen A. Thole, Professor and Department Head, MNE Department
Dr. Mary Frecker, Associate Department Head of Graduate Studies, MNE Department
Dr. Tim Simpson, Professor of Mechanical Engineering and Industrial Engineering
To be named, Staff Assistant in the Graduate Office, MNE Department, who will serve as the primary contact within the Department for the online students
To be named, Instructional Designer, Mechanical and Nuclear Engineering, who will serve the faculty’s online course development
Ms. Sonya Leitzell, Director of Academic Affairs, World Campus, who will serve as the person who will coordinate the online MEngAMD degree program with the World Campus

2. Academic Support to Students

Resident students will be supported through the Mechanical and Nuclear Engineering Department’s Graduate Office given the program will be housed in that department. In addition, project advising will take place in each of the respective departments. Online students will be supported through student scheduling, registration, and billing which are all integrated into the World Campus support system for students. The reporting of grades will occur through Lion Path. The Help Desk will provide the needed technical support through email or by phone.

As stated on Penn State’s World Campus website, the following support will be provided by World Campus to our online students:
— walking students through the program application process, including identifying the required supporting documentation; finding financial aid, scholarships, and other types of financial support; and preparing them for learning in an online environment;

— using University systems to access course syllabi and assignments; interact with professors and peers; make tuition payments; order textbooks and software through the online bookstore; and use the University Libraries system;

— providing resources for online students including career counseling, exam proctoring and tech support;

— linking online students with communities and special services for military members and veterans, international students, alumni, corporate education, students with disabilities, and those transferring from other universities and colleges; and

— providing connections for the online students to the Penn State community by keeping students up-to-date with events, important dates, and Penn State news.

3. Instructional Design Support and Available Facilities

Only the laboratory component of the proposed degree program requires specialized facilities for the program. These laboratory facilities include those contained in CIMP-3D, the Materials Research Institute, the Learning Factory, and the FAME Lab.

The online course delivery for the MEngAMD degree will coincide with the resident course delivery for one semester each year while offerings to the online students will be multiple semesters throughout the year. While the online students will be able to view the lecture synchronously or asynchronously, the resident students will receive the information live at the specified course meeting times. Several resources, however, will be provided to the students and faculty to ensure a successful online and resident course delivery. Each of the Department (and School) Heads has ultimate responsibility to ensure course material is developed to meet the program delivery schedule.

CANVAS will be the primary web-based course management system. Through CANVAS, students will receive the needed course materials (syllabi, readings, etc) and lectures. CANVAS also supports access to course content including asynchronous threaded discussion and real-time chat, automated quizzing with immediate feedback, grade management, and reporting functions.

To assist faculty members in converting existing course material to a fully online environment, we will make use of an Instructional Designer who will be hired and shared by the Departments participating in the MEngAMD Program. The Mechanical and Nuclear Engineering Department will make use of their experiences and lessons already learned in their online MSME and MEngNucE Programs. Videoconferencing will be made possible through the dedicated online recording classrooms in the Mechanical and Nuclear Engineering Department as well as the College of Engineering.

There are also numerous resources at Penn State for faculty teaching online courses through the Penn State Learning Design Community Hub, which is a website devoted to staff and instructors working with instructional technology (http://wcfd.psu.edu/).
4. Technological Resources Needed by Online Students

Students in the online MEngAMD degree program are expected to possess or have access to a personal computer and a broadband internet connection. The minimum system and software specifications are outlined at http://ets.tlt.psu.edu/learningdesign/. No specific hardware or equipment is required to complete the program.

G. Consultation with Other Units Affected by the Proposed Program

Written responses indicating consultation with other units are identified below. Responses are included in the appendix.

<table>
<thead>
<tr>
<th>Units Consulted</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penn State – Great Valley, James Nemes, Chancellor</td>
<td>positive</td>
</tr>
<tr>
<td>World Campus, Renata Engel, Associate Vice Provost of Online Programs</td>
<td>positive</td>
</tr>
<tr>
<td>Libraries, Barbara Dewey, Dean (Bonnie Osif, Librarian)</td>
<td>positive</td>
</tr>
<tr>
<td>Earth and Mineral Sciences, Assoc Dean John Hellmann</td>
<td>positive</td>
</tr>
<tr>
<td>Aerospace Engineering, P. Morris</td>
<td>positive</td>
</tr>
<tr>
<td>Architectural Engineering, K. Parfitt</td>
<td>positive</td>
</tr>
<tr>
<td>Bioengineering, C. Dong</td>
<td>positive</td>
</tr>
<tr>
<td>Chemical Engineering, P. Savage</td>
<td>positive</td>
</tr>
<tr>
<td>Civil and Environmental Engineering, P. Fox</td>
<td>positive</td>
</tr>
<tr>
<td>School of Electrical Engineering and Computer Science, T. LaPorta</td>
<td>positive</td>
</tr>
<tr>
<td>Supply Chain and Information Systems, N. Petruzzi</td>
<td>positive</td>
</tr>
<tr>
<td>Information Sciences and Technologies, Andrew Sears, Dean</td>
<td>positive</td>
</tr>
<tr>
<td>Penn State – Harrisburg, Mechanical Engineering, Issam Abu-Mahfouz</td>
<td>positive</td>
</tr>
<tr>
<td>Penn State – Office of Research Protections, D. Poveromo</td>
<td>positive</td>
</tr>
<tr>
<td>Penn State – Erie, W. Lasher</td>
<td>waiting</td>
</tr>
</tbody>
</table>

H. Program Quality

Assessment of the program quality will continuously be done through multiple avenues. The assessment plan will include tracking the following statistics: faculty’s Students’ Rating of Teaching Effectiveness scores (SRTEs); enrollments; entering graduate student quality in terms of experience, grade point averages, and GRE scores; student diversity in terms of professional and academic backgrounds, gender and ethnicity; time to degree; publications of culminating papers; internship experiences; and student placement.

Peer teaching reviews will be conducted each semester for non-tenured faculty members and annually for Associate Professors. Students’ assignments are submitted electronically through
their online classroom environment—just like they would turn them in to their professor on campus. Most exams are taken through an approved University proctor. Once a student is enrolled, we will help them secure a proctor nearby.

Exit surveys as well as post-graduate surveys will also be developed and provided to those graduating from the program. These surveys will be constructed through the help of an assessment expert.

It will be the responsibility of the Department Heads, Associate Department Heads of Graduate studies and the Director of the Academic Affairs in World Campus to ensure that the program is maintained at a high quality. Per Graduate Council policy, the Departments and School will report back to the Committee on Programs and Courses three years after the initial enrollment of the first cohort of students with information to assess success and quality of the program. Guidelines for reporting are provided by the Office of the Dean of the Graduate School.

One additional measure of quality to be tracked will be the research papers that are written to meet the degree requirements. It is expected that the research papers, in particular, will be of publishable quality as is stated in the degree requirements. Papers that are produced through the degree program will be graded in terms of quality by the faculty adviser, the second reader, and the Graduate Program Officers in each of the five Departments and School. As mentioned, the papers will be tracked to see whether a published document is produced from the research.
Appendix A: Graduate Bulletin Statement

Additive Manufacturing and Design
KAREN A. THOLE, Head of the Department of Mechanical and Nuclear Engineering
137 Reber Building
814-865-2519

Graduate Faculty:
- Engineering Science and Mechanics
- Industrial and Manufacturing Engineering
- Material Science and Engineering
- Mechanical Engineering
- School of Engineering Design, Technology, and Professional Programs

Degree Conferred:
- M.S. in Additive Manufacturing and Design (resident)
- M.Eng. in Additive Manufacturing and Design (online)

The Program
The overall goal of the Master’s of Science in Additive Manufacturing and Design and Master’s of Engineering in Additive Manufacturing and Design are to educate students and working engineers to become technically outstanding experts in additive manufacturing. Specifically, the objectives include:
1. Apply foundational knowledge, critical thinking, problem solving, and creativity in the uses of additive manufacturing and associated design tools and methods.
2. Grow as leaders in manufacturing while maintaining the highest ethical standards in applying additive manufacturing to industry-relevant problems and design challenges.
3. Strive for the advancement of the state-of-art in additive manufacturing and design.
4. Develop innovative solutions through new design paradigms in their respective industries.

Admission Requirements
Admission requirements listed here are in addition to requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin. Applicants apply for admission to the program via the Graduate School application for admission. The language of instruction at Penn State is English. English proficiency test scores (TOEFL/IELTS) may be required for international applicants. Consult the English Proficiency section of the Graduate Bulletin Application and Admission Procedures page for more information.

To maintain a high quality program, it is important that our students are of a caliber to succeed. As such, the admission requirements for the students enrolling in the MSAMD and MEngAMD degree program will be based on: academic records, GRE scores, applicable work experience, their personal statement of interests in additive manufacturing design, and three letters of recommendation from a previous professor or supervisor who can attest to the applicant’s academic potential. Applicants will be expected to have a Bachelor of Science or four-year Associates degree from an accredited institution in engineering, manufacturing, materials science, or related field. An undergraduate cumulative grade point average of 3.0 or better on a 4.0 scale in the final two years of undergraduate studies is required.
Degree Requirements
Requirements listed here are in addition to requirements stated in the DEGREE REQUIREMENTS section of the Graduate Bulletin.

1. A minimum of 30 credits at the 400, 500, or 800 level is required. For the M.S., at least 18 credits must be in 500-level courses. For the M.Eng., at least 18 credits must be at the 500 or 800 level, with a minimum of 6 credits at the 500 level.

2. Completion of 5 required courses that total 19 credits with a grade point average of 3.00 or higher. The 5 required courses are EDSGN 562 (4 credits), E SC 545 (4 credits), IE 527 (4 credits), MatSE 567 (4 credits), and ME 566 (3 credits).

3. A minimum of at least 8 credits in 400 and/or 500 level courses offered with the following designations: EDSGN, E SC, IE, MATSE, or ME. Note that EDSGN 596, E SC 596, IE 596, MATSE 596, and ME 596 cannot be used to fulfill this requirement.

4. Completion of 3 credits in one of the following offerings to complete the culminating project: EDSGN 596, E SC 596, IE 596, MATSE 596, or ME 596. MSAMD students will be required to complete one (1) credit in each of three (3) semesters while MEngAMD students can complete a three (3) credit course in one (1) semester.

5. A scholarly paper must be completed to meet the specific requirement of the culminating experience. This paper will demonstrate depth of knowledge to his/her adviser, a second reader, and the Associate Department Head of Graduate Studies in one of the five aforementioned Departments.

6. All students must successfully complete one credit of colloquium preferably in their first two semesters in the program. The one-credit colloquium does not count toward the 30 graduate course credits in Requirement 1 above. The following courses are offered to meet this requirement: EDSGN 590, ESC 514, IE 590, MATSE 590, and ME 590.

7. All students will be required to complete SARI (Scholarship and Research Integrity) training.

The M.S. degree is designed to be completed in 3 semesters, or one calendar year (fall, spring, and summer). A research adviser will be assigned to students in their first semester. Students who need more time to complete the final paper will be allowed to complete the paper, and have it reviewed and approved after the third semester has ended. Students are not required to remain in residence while they complete the final paper. However, extensions granted to students in this program must comply with the Graduate Council policy on deferred grades.

CULMINATING EXPERIENCE - MS PAPER and MEng PAPER
Candidates must write a culminating project paper on a topic mutually agreed upon with the adviser. Students will be encouraged to utilize an industry internship (resident students) or current employer (online students) to identify a relevant or practical problem of importance that additive manufacturing and appropriate design methods could address. The quality of the required paper is such that it must be suitable for publication in a professional journal or
proceedings at a national or international conference, which generally requires a peer-review process.

**Student Aid**
Graduate assistantships available to students in the residential program and other forms of student aid are described in the Student Aid section of the Graduate Bulletin. Students on graduate assistantships must adhere to the course load limits set forth in the Graduate Bulletin.

World Campus students in graduate degree programs may be eligible for financial aid. Refer to the Tuition and Financial Aid section of the World Campus website for more information.

**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.”
Appendix B: Expectations for Culminating Paper

To ensure that MS and MEng papers is of the quality of accepted professional quality standards, the following guidelines have been established by the mechanical engineering graduate faculty. Compliance will be monitored and enforced by the paper advisor, the paper reader, and the Associate Head of Graduate Programs.

In content, length and structure, the paper is expected to be one that would be acceptable for publication in a peer-reviewed professional journal, or for presentation at a peer-reviewed national or international conference. Examples of papers that would not meet this standard would be a technical report to a sponsor, a presentation at a local or regional conference, or a presentation at a conference where selection is not based on a full-paper peer-review process.

In the case of a multiple-author paper, the degree candidate must be the first author, and the paper must be primarily the work of the degree candidate. If there are coauthors other than the degree candidate and his/her faculty advisor, then a brief summary of the contributions of each coauthor and an estimate of each coauthor's percentage of effort must be included.

If the paper has already been published and/or presented, or has been accepted for publication and/or presentation, then the actual journal- or conference-formatted paper or manuscript should be submitted. Documentation must be provided to show that the paper has been published and/or presented, or has been accepted for publication and/or presentation. The role of the reader in this case is primarily to confirm that the target journal or conference meets the criteria outlined above, and that the documentation is in order.

If the paper has been submitted for publication or presentation, but has not yet been accepted, then the actual journal- or conference-formatted manuscript should be submitted. Documentation must be provided to show that the manuscript is under consideration for publication and/or presentation. If reviewer comments are available, those should be provided. In addition to confirming that the journal or conference is appropriate, the reader in this case will effectively have the role of a peer reviewer, and will judge whether the manuscript is, in principle, suitable for publication in the target journal or presentation at the target conference.

If the paper has not yet been submitted for publication and/or presentation, but will be in the near future, then the requirements in the previous paragraph still apply, with the exception of the requirement to provide documentation that the paper is under consideration.

Finally, if the paper is not one that has been or will be submitted for publication or presentation, then an appropriate target journal or conference must be selected by the student and paper advisor, and the paper must be prepared as if it were going to be submitted to that journal or conference. An appropriate template to use in this case would be the one that is available for professional technical papers, for example (see http://www.asme.org/kb/proceedings/proceedings/author-templates). In this case, the paper reader must judge whether the paper would be acceptable, in principle, for publication in the target journal or presentation at the target conference. This option will place a greater burden on the reader, as he/she will not have the advantage of knowing that external peer reviewers are also reading and evaluating the paper.
Appendix C: Consultation with Other Units Affected by the Program

From Professor Cheng Dong, Dept Head, Biomedical Engineering
hi Karen,
BME grad curriculum reviewed your proposal along with me. We support the proposal.
BME is expanding bio-manufacturing and tissue engineering areas. So if help is ever needed in
biomedical applications from your Additive Manufacturing and Design, BME will be there to assist and
support you.
For example, Jian Yang leads a Transformative Biomaterials and Biotechnology Lab and investigates a
methodology for functional biomaterial development and uses biomaterials as a tool for bio-
manufacturing tissues.
In 2015-16, we hired Xiaoyun (Lance) Lian, whose research focuses on bio-manufacturing clinical
applicable cells from human stem cells, such as the cardiomyocytes, neurons and/or pancreatic beta
cells.
In our current 2017-18 search, BME will join Chemistry to co-hire a faculty in areas of
biosynthesis, applying nature and biology as guidelines for the development of novel chemical tools,
methods, or biomaterials that address biomedical problems in bio-manufacturing for the (re)generation
of tissue and organs. Areas of particular interest include: the synthesis of biomolecules (e.g. proteins,
peptides and nucleic acids) for applications such as bio-manufacturing, manipulation or probing of
biological processes, as well as biomimetic synthesis of nanoscale materials for macroscopic
manufacturing of tissue or organ mimics.
Good luck with your proposal.
Best,
Cheng

________________________________

From Dr. Phil Savage, Dept Head, Chemical Engineering
Karen
I looked over the document you sent regarding the new MS degree. It looks like a very nice program and that
it will give Penn State a leadership position. I am supportive.

Phil

________________________________

From Dean Andrew Sears, Dean, College of Informational Science and Technology
Karen,

Thanks for sharing this proposal. I shared it with the college’s Associate Deans who address academic
programs and they agreed that we do not see any issues or concerns from an IST perspective. If there’s
interest in exploring the risks that come along with these ideas, I may have some people who would be
interested in talking about this and ensuring appropriate content is integrated into a corresponding IST
course. Just let me know if there is interest.

Thanks,
Andrew
Dear Nicholas,

Thank you very much for the time and effort you took to review our proposal. I am aware of your program, particularly with IE 527. In principle, what you are suggesting is very much welcomed. We would be pleased to accept your students into courses associated with this MSAMD degree program. It makes sense to share resources as best we can. I suggest that once we have our program approved, we meet to talk about an MOU that outlines an agreement on the courses regarding enrollments, financials, etc.

Thank you again and we appreciate the help. I look forward to working with you.

Karen

From: Nicholas Petruzzi [mailto:ncp12@smeal.psu.edu]
Sent: Saturday, September 24, 2016 1:23 PM
To: Karen Thole <kthole@engr.psu.edu>; ncp12@psu.edu
Cc: Peter J. Butler <pjbbio@engr.psu.edu>; Janis P. Terpenny <jpt5311@engr.psu.edu>; Judith Todd <JTodd@engr.psu.edu>; Sven Bilen <SBilen@engr.psu.edu>; sinnott@matse.psu.edu; Mary Frecker <mxf36@engr.psu.edu>; kthole@psu.edu
Subject: RE: MS in Additive Manufacturing and Design

Dear Karen,

Thank you for consulting me on this proposal. Overall, I lend my support. Indeed, I look forward to any potential synergies it generates with our SCM programs and industry partners. On that note, I offer up a question as food for thought: Would courses in this degree program be available as electives to students enrolled in other graduate degree programs? I ask because we typically have students in our MPS in SCM program who express keen interests in taking advanced manufacturing courses from Engineering. To wit, we currently have a track of students taking a three course sequence in IE, namely IE 573 (Manufacturing Material) + IE 574 (Advanced Manufacturing Processes) + IE 527 (Additive Manufacturing). Given that some or all of these particular courses would satisfy degree requirements for the proposed MS in Additive Manufacturing and Design, I think there are potential strategic-level
synergies and operational efficiencies to be had from some level of concerted coordination across programs.

Sincerely,

Nick

________________________________
From Professor James Nemes, Chancellor, Penn State Great Valley

Dear James,

Thank you so much for your comments regarding our proposal. We appreciate your willingness to review and respond in such a timely manner. Below are our responses. Please feel free to let us know whether this satisfies your concerns.

Karen

From: JAMES A NEMES [mailto:jan16@psu.edu]
Sent: Tuesday, September 20, 2016 8:30 AM
To: Karen Thole <kthole@engr.psu.edu>
Cc: Peter J. Butler <pjbbio@engr.psu.edu>; Judith Todd <JTodd@engr.psu.edu>; Janis P. Terpenny <jpt5311@engr.psu.edu>; Sven Bilen <SBilen@engr.psu.edu>; sinnott@matse.psu.edu; Mary Frecker <mxf36@engr.psu.edu>; kthole@psu.edu; DAVID RUSSELL <RZN@PSU.EDU>
Subject: RE: MS in Additive Manufacturing and Design

Karen,

This is obviously a very timely proposal, and Penn State is well-positioned to deliver it, so I am therefore very supportive.

Thank you so much for your comments.

I do have a few comments on the proposal, which are listed below:

1) I recognize this is part of a larger discussion, but it seems that this would more appropriately be considered an M.Eng. rather than an M.S.
We have now changed this degree to an MEng for the online students and an MS for the resident students with the appropriate requirements for each in terms of the culminating paper. MS students will be required to enroll in one credit of research each of three semesters.

2) Unless I’m missing it, I don’t see EDSGN 562, E SC 545, IE 527, or ME 566 in the graduate bulletin. Our experience has been that programs will not be approved unless the required courses for it have been approved. Also makes it difficult to review the program proposal without knowing the content of these courses.
Many of these courses are making their way through the process now. These should appear soon and prior to the program proposal review. Nearly all are in the works or are already completed.
3) It’s not clear from the offering schedule in section 5, if those courses are online courses or resident courses or both. These courses will be offered both online and in resident.

4) In several places of the proposal there is a mention of ‘one-year master’s programs’ but it seems this program is directed more toward online students who would take three years. The one year master’s program references seem misleading. We want to offer this degree both online and as a one year M.S. The proposal indicates such.

5) The proposal states that the online students will also take ME 566, which is a ‘hands-on’ lab course. Is this a 15 week course? Would the online students spend a semester at University Park? The proposal didn’t specify how this would work. The expectation for this particular course is that students will be required to be on campus for two three-day, intensive visits to learn the required material in ME 566. Tim Simpson already teaches a very popular industry practicum, which we will build upon for ME 566.

Jim
James A. Nemes, D.Sc.
Chancellor and Chief Academic Officer
Professor of Mechanical Engineering
School of Graduate Professional Studies
Penn State Great Valley
30 East Swedesford Road
Malvern, PA 19355-1443
Phone: 610-648-3335
Fax: 610-648-3377
jan16@psu.edu

From Professor Phil Morris, Aerospace Engineering

Karen:
All the feedback from those faculty members who replied has been positive.
I will complete the form if I can log in from Spain.
Phil

From Professor Pat Fox, Civil and Environmental Engineering

Hi Karen -

The CEE Department is supportive of this new degree program, with no concerns. The topic, justification, and outline are well-considered and will be of significant benefit to the college. There is minimal overlap with our CEE programs.

Please let me know if you need any further feedback.
From Professor Kevin Parfitt, Architectural Engineering

Karen,

Based on my review of the material provided, I feel this is an excellent new program that pulls together knowledge from a number of sources at Penn State into a timely and comprehensive degree program. Given the topic, I feel the required internship is especially appropriate and will benefit those students who do not have much (or any) industry experience and will make the program attractive to students because of the industry interaction. There are no overlaps or duplication of effort in the program relative to Architectural Engineering. As such, you have my support for the new degree program in Additive Manufacturing and Design.

Thanks for including me in the review process.

Good luck!

Kevin

From Professor Tom Laporta, School of Electrical Engineering and Computer Science

Karen,

I am positive on your new MS degree. There is minimal overlap with our programs and is very well formulated.

Regards,

Tom

From Professor Issam Abu-Mahfouz, Penn State-Harrisburg, ME Department Chair

From: ISSAM ABU-MAHFOUZ
Sent: Tuesday, December 20, 2016 11:25 AM
To: Karen Thole <kthole@engr.psu.edu>
Subject: Re: Request for consultation of MS in Additive Man and Des

Hello Karen,
I read, with interest, your proposal for the graduate (master) programs in additive manufacturing. The proposal was clear and well organized. I just have two comments that are related and please excuse my ignorance about any factors, not visible to me, that justify the need for two degrees instead of just one in AMD!

1. Since the two programs, resident MSAMD and online MEngAMD, are practically identical with exception of the 3 credit culminating project/paper, I personally don't see that the 3 credits are strong justification to create two different master degrees.

Quite honestly, we could not agree more. Unfortunately, the Graduate School does not permit MS online degree programs. The one exception to this strictly enforced rule is our own MSME online degree program, which was only permitted to be an experimental test case.

2. Reading that students enrolled in the online program (MEngAMD) need to spend some on-campus lab (hands-on) time at UP or at their workplace and the fact that most if not all of the courses for the two proposed programs are readily available online, I don't see a strong need for the first resident degree in MSAMD.

The time spent on campus will amount to two three-day weekends. We believe, however, that there will not only be strong interest from those already working in industry (online) but also from our residents students who want to be resident. Since the MS degree is of higher interest to companies hiring our students, we want to make sure we are giving the correct degree to our resident students. We are unable to change the Graduate School’s rules regarding the online MEng so it must be an MEng.

I would suggest one online Master's degree in AMD with the option of a 3 distributed research oriented project and another option of a one 3 credit course that is application oriented. Both of course have to result in a master's paper.

We could not agree more, but this is not permitted.

I noticed that at bottom of page 7 (The requirements of the proposed MSAMD degree are: ...) should read (The requirements of the proposed MSAMD and MEngAMD degrees are:) since there is no separate list for the MEngAMD in the proposal. Also, on page 5 (top) .... as design, is not as it looks or as is portrayed to the general public. Or may be ( ...... looks or as portrayed ...)!

Thank you. Changes have been made.

We never met before! I would like to see if I can visit UP, may be accompanied by some Harrisburg faculty, to meet with you and to discuss opportunities for collaboration.

Please do visit!

Best Regards,
Issam

From Debrah Poveromo (Katherine Bode-Lang), Office for Research Protections
Dear Katherine,

Thank you so much for your quick response. Please see my comments below.

Happy holidays and thank you again.

Karen

From: Poveromo, Debrah [mailto:dap192@psu.edu]
Sent: Tuesday, December 20, 2016 11:12 AM
To: Karen Thole <khole@engr.psu.edu>
Cc: Bode-Lang, Katherine <kfb119@psu.edu>
Subject: New degree proposal

Hello Dr. Thole,

Thanks for reaching out to the ORP to consult with our office regarding your two new masters of engineering programs. I am the Education Coordinator and manage the SARI Program. Katie, our Director, forwarded me your request. I looked over both proposals for additions to the Additive Manufacturing and Design offering. I am happy to see the one-semester, one-credit colloquium requirement for graduate students included. I also appreciate the videotaping of the lectures for the online students. Will this requirement be met in the first year of the program? 

Yes, this requirement will be met in their first semester of enrollment and will be enforced by the home department’s graduate office in MNE.

I went back and looked at the COE SARI Program that was submitted in 2009-10. It appears that all of the COE programs follow a close version of this plan. The requirements include the Collaborative Institutional Training Initiative (CITI) online training program. With this program, students will take the RCR modules in Engineering and Physical Sciences as part of their SARI training. Additionally, five hours of training will be required and two of those hours can be completed by attending various OPR SARI workshops that are offered in the fall and spring of each academic year. The remaining three hours can be obtained by the colloquium, through specific lectures relating to ethical research. A list of potential topics are given in the COE plan stated below:

• Acquisition, management, sharing, and ownership of data
• Publication practices; responsible authorship
• Conflict of interest and commitment
• Research misconduct; professional and research ethics; bioethics
• Mentor/trainee responsibilities; Peer review
• Collaborative science; human subjects protections
• Government/industry interactions; lobbying
• Resisting political pressure over technical decisions
Technology transfer; ITAR requirements; globalization/cultural perspectives

In summary, it appears the new programs will require the colloquium which will cover all five of the hours and students will not need to attend any of the ORP SARI trainings. Students will still be expected to take the CITI training. RCR will be the standard training, however, students must take the IRB training if conducting human subject research anytime in their program.

Please confirm if I am capturing this information correctly. Once you hear that your proposal has been accepted, you will need to complete a SARI Program Plan.

Yes, this is correct. We will file a plan shortly.

The template can be found here: https://www.research.psu.edu/node/316
Then, a file will be set up in Box where we will house your program plan and SARI tracking form. A link will be provided to that file.

Again, thank you for reaching out to the ORP. Please email or call if you have any questions for me.

Good luck with your new programs!

Sincerely,

Deb

Debrah A. Poveromo
Research Protections Education Coordinator
Office for Research Protections
The 330 Building, Suite 205
The Pennsylvania State University
University Park, Pa. 16802
dap192@psu.edu
(814) 863-1441
To: Karen Thole, Department Head, Mechanical and Nuclear Engineering

From: Renata Engel, Associate Vice Provost for Online Programs

Date: October 21, 2016

Subject: Proposed M.Eng. in Additive Manufacturing

Copy: Peter Butler, Associate Dean for Education, College of Engineering
Karen Pollack, Assistant Vice Provost for Online and Blended Programs
Sonya Leitzell, Director of Academic Affairs, World Campus

The World Campus is pleased to continue its partnership with the Department of Mechanical and Nuclear Engineering, College of Engineering and to provide feedback on the proposed M.Eng. in Additive Manufacturing, for delivery on the World Campus.

We applaud the efforts of the department to leverage the existing World Campus investment in the update of the online M.S. in Mechanical Engineering in support of the development of new content areas and the investment of additional support resources. In addition, the proposal shows a thoughtful, interdisciplinary approach to the emerging curriculum in an area where Penn State has noted expertise: additive manufacturing and 3-D printing. While additive manufacturing is an emerging topic in engineering, it is unclear the rate of growth of this specialty in a manufacturing sector that is projected to decline over the course of the next decade. Should additive manufacturing continue to grow and become more commonplace in the manufacturing sector, it will likely lead to universities incorporating this content into undergraduate engineering curricula in the coming years.

We do have some additional feedback to share:

- We believe the market size for the program will be smaller than the MS ME, both in residence and online.

- Our experience with other programs that require residencies tell us that while necessary to achieve the program objectives (in this case the hands-on experience), a residency requirement will nonetheless further limit enrollments in the online program. We understand, however, that a successful program must include a residential component.

- Four of the required courses are designed as 4-credit courses and described in the program proposal as allowing flexibility to incorporate a 1-credit lab component. This level of flexibility will have to be carefully considered for online delivery. The course proposal should include sufficient details regarding the 1-credit laboratory component so that the entire program can be evaluated for applicability for online delivery.
Memorandum

To: Engineering Faculty Council
From: Karen A. Thole, Department Head, Mechanical and Nuclear Engineering

Subject: Response to Graduate Studies & Research Committee Comments on Additive Manufacturing and Design Degree Proposal
Date: December 11, 2016

This memorandum is in response to the comments from the GS&R Comments associated with the Additive Manufacturing and Design offering as a Resident Master’s of Science and Online Master’s of Engineering Degrees. The comments are repeated below along with the responses that were provided.

Comment: I agree. The requirements for the MS should be much higher and comparable to what students have to do for other MS courses on campus.
Response: The proposed degree program is closely modeled after our Master’s of Science in Mechanical Engineering with the same number of credit hours. In addition, the Master’s of Science in Mechanical Engineering also provides for a paper option rather than a thesis as does the proposed degree. The Master’s of Science in Mechanical Engineering with the paper option requires 30 course credits as does the proposed degree program. As such, there are comparable requirements to existing resident (on campus) MS degree programs.

Comment: Looks good overall. I agree in wondering whether the final paper subject is enough to distinguish the 2 programs (especially because there is presumably significant room for overlap between the practical and theoretical here).
Response: We expect the differences to be significant between the subjects for the final papers between the Master’s of Science and Master’s of Engineering due to the nature of the students. For the Master’s of Science, students will complete the final paper using the research lab and computational resources on-campus. For the resident students, the ideas for the culminating paper may arise from an industry internship but the research will take place on campus as a result of the requirement of one credit hour per semester for three semesters. The infrastructure on campus by its very nature of being at an institution such as Penn State is suited for research rather than production or product development. In contrast, the online Master’s of Engineering students will complete their projects in only one semester while working in industry, which is focused on new products and the development of those new products and, as such, the paper will be more application based. We expect that the papers to reflect these differences. In the original proposal, the following description was given on pg. 7:

The choice of their project topic will be mutually determined by the student and his/her advisor and take into consideration that an MEng paper focuses on practical applications in the workplace, while the MS paper focuses on integrating various fundamental concepts into new knowledge or processes. The written paper based on the project must contain a project description, literature review, results, analysis, and interpretation of its findings as further described in Appendix B.

This has now been changed on pg. 7 to reflect the comment to read:

The choice of their project topic will be mutually determined by the student and his/her advisor and take into consideration that an MEng paper focuses on practical applications in the workplace, while the MS paper focuses on integrating various fundamental concepts into new knowledge or processes.

It is...
important to note that the MS paper will be completed through three semesters of research on campus in which the students must register for one credit during each of the three semesters. The MS paper is expected to contribute to a better fundamental understanding of the additive manufacturing process and design. The MEng paper will be completed during only one semester while the student will be off-campus. The MEng paper is expected to contribute to the application of additive manufacturing in terms of the development of new products. The written paper based on the project must contain a project description, literature review, results, analysis, and interpretation of its findings as further described in Appendix B.

**Comment:** This looks like an interesting new program. Overall, I am supportive. However, I do wonder if just the difference in final project/paper focus (theoretical vs practical) is sufficient to differentiate the MS and MEng degrees. It seems that the students will take the same core courses for these two degrees - all of which are listed at the 500-level. Should some of the MEng coursework be 800-level? How will the core courses adequately provide depth in both theory and practical application for the two different groups (MS and MEng students) taking the same course?

**Response:** The response provided above outline the differences on the final project/paper. Regarding the question about the core courses, we have specifically designed this program to encompass both theory and practical application. In particular, the required laboratory course (ME 566) will be a very practical course in which the students will learn the usage of additive manufacturing. In contrast, all of the other courses will have a strong theoretical basis but yet bring in many practical applications, as do most engineering courses. We also believe the strength of this program is to have the interaction between the resident (MS) and online (MEng) students who will be mixed in the courses. Having a mix of these students will provide a rich learning environment for both and we would not want to dilute that educational opportunity by separating the students into 500 and 800 level courses.
Graduate Council
Program, Option, or Minor Proposal Form

Submit 1 original, signed Graduate Council proposal form and 2 hardcopies of the graduate program proposal document, with a copy of the signed proposal form attached to each proposal copy, to the Office of the Dean of the Graduate School, 211 Kern Building, University Park. For more information about the process, see the Overview of the Graduate Council Curricular Review Process.

The Program Proposal Procedures provide guidance for the development of a graduate program proposal. If you have questions regarding the preparation of a graduate program proposal or how to complete this Graduate Council proposal form, contact the Office of the Dean of the Graduate School.

College/School: College of Medicine
Department or Instructional Area: Biomedical Sciences

New Graduate Program, Option, or Minor: Add X
Designation of new graduate program: ____________________________
Classification of Instructional Programs (CIP) Code: ____________________________
Designation of new graduate option: Cellular and Integrative Physiology (CIP)
Designation of new graduate minor: ____________________________

Indicate effective semester:
First semester following approval X
Second semester following approval

Existing Graduate Program Option, or Minor: Change X Drop
Current designation of graduate program: Biomedical Sciences
Current designation of graduate option: Biochemistry and Molecular Genetics; Translational
Current designation of graduate minor: Therapeutics; Virology and Immunology

New designation of existing graduate program (if changing):
New designation of existing graduate option (if changing):
New designation of existing graduate minor (if changing):

Brief description of the change (if not noted above): Changes to required courses; required publication

Indicate effective semester:
First semester following approval X
Second semester following approval

Submitted by Graduate Program Head
Ralph L. Keil, Ph.D.
Printed name
Signature
Date: 1/23/16

Noted by College/School Representative to Graduate Council Subcommittee on New and Revised Programs and Courses:
Gail Matters, Ph.D.
Printed name
Signature
Date: 1/23/16

Approved by College/School Dean/Chancellor (or Designee):
Charles Lang, Ph.D.
Printed name
Signature
Date: 1/23/16
Recommended by Chair, Graduate Council Subcommittee on New and Revised Programs and Courses:

On Behalf of John Challis
Printed name
Signature
Date: 3/7/2017

Recommended by Chair, Graduate Council Committee on Programs and Courses:

On Behalf of M. Kathleen Heid
Printed name
Signature
Date: 3/7/2017

Noted by Dean of the Graduate School:

On Behalf of Regina Vasilatos-Younken
Printed name
Signature
Date: 3/7/2017
Program Changes for the

Biomedical Science Graduate Program and its Options

ORIGINAL SUBMITTED: November 28, 2016
REVISION SUBMITTED: February 19, 2017

Respectfully submitted by

Ralph L. Keil, Ph.D.

Chair, Biomedical Sciences Graduate Program

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I. Justification

We respectfully submit this program change proposal to 1) add the Cellular and Integrative Physiology (CIP) Option to the Biomedical Sciences (BMS) Graduate Program, 2) modify the required curriculum of the BMS Graduate Program, and 3) add a requirement for at least one first-author publication accepted or published based on the student’s dissertation research prior to the final oral examination.

1) Addition of the CIP Option will provide an important opportunity for students in the BMS Graduate Program to receive training in cellular and integrative physiology. The specialized curriculum for this Option will provide students with the necessary background to conduct and evaluate research in the labs of the current 20 faculty members who organized this Option. Research in these labs includes the functions and interactions between different tissues and cell types and different organ systems. Examples of specific topics of research in these labs include metabolic disorders, metabolism and nutrient signaling, muscle function, vascular and endothelial function, cell signaling, and ion channels.

2) Several undertakings are represented among the curricular changes being proposed.

   a) The College of Medicine has a strong, internationally recognized record [e.g., see Cell (2011) 147: 1207-8] for the initial courses taken by students entering the laboratory research-intensive graduate programs at Penn State Hershey. This has been termed the ‘core curriculum’. Part of this effort involves reviewing and modifying this curriculum on a regular basis. Over the last three years, this curriculum has been modified to a) place more emphasis on students understanding concepts instead of learning facts; b) decrease the time in classes during their first Fall semester to provide more student-directed learning outside the classroom; and c) utilize active-learning styles to make students responsible for more of their own learning. These changes have led to a decrease in the classes and credits (decreased from three 3-credit courses to two 3-credit courses) in the ‘core curriculum’.

   b) Addition of a new course to the ‘core requirements’ for all Ph.D. students in the BMS Graduate Program that provides instruction and practice in grant writing skills (BMS 801). Material in the course emphasizes grant writing (e.g., fellowships), hypothesis generation, experimental design, and understanding of expected results. Development of these skills is critical for success both in the Ph.D. program and in a variety of careers in biomedical sciences.

   c) Addition of a new required course, BMS 512, for the Biochemistry and Molecular Genetics (BMG) Option that focuses on both computational analysis, especially of large data sets, and statistical analyses used in biomedical research. This course will prepare students to be able to examine the large quantitative data sets common to many research undertakings in biochemistry and molecular genetics and to insure their experimental designs and findings are rigorous and reproducible.

   d) Breaking some 4-credit courses into several 1- or 2-credit courses. A motivating factor for this change is to make these courses of potential interest as electives to students not in the
specific Option. The Translational Therapeutics Option did this when the BMS Graduate Program was first formed and it has worked well.

e) Addition of new required courses for the Virology and Immunology (VIRIM) Option. Some of these new requirements are due to the change summarized in Item d) above while others are due to new courses.

f) Having several courses that students in the VIRIM Option may choose to take one or the other. This permits students in the Option to acquire i) a breadth of knowledge in both virology and immunology, by having courses that are required for all students in the Option, and ii) a depth of knowledge in virology or immunology, depending on their dissertation research and interests. This change is also consistent with decreasing time in classes to permit more time to focus on individualized learning required for the student’s dissertation research.

g) Addition of a new course requirement for M.D./Ph.D. students, BMS 512 Data Analysis for the Biomedical Laboratory Scientist: A Practical Approach (2 credits). The material covered in this course prepares students to deal with analysis of large data sets that are common to many experiments in biomedical studies. This course also emphasizes the need for rigor and reproducibility in biomedical sciences.

These credits will be in place of BMS 504 and BMS 505 The Art of Scientific Communication I and II (each 1 credit). The presentation and scientific writing skills that are a focus of BMS 504 and BMS 505 are incorporated into BMS 506A and BMS 506B Biological Basis of Health and Disease A and B (2 credits each) that are required for M.D./Ph.D. students.

h) Removal of Options for M.D./Ph.D. students: Content of some option-specific courses overlaps substantially with information in required medical courses taken by M.D./Ph.D. students. Thus, it is not feasible for M.D./Ph.D. students to fulfill the Graduate Council policy that at least one-third of the credits for an option be from option-specific courses without having students take courses with fairly repetitive content.

i) Addition of a requirement to take one credit of BMS 590 each year throughout a student’s graduate career. Students are currently required to attend these seminars but that attendance is not given the credit that it warrants. Adding this credit formalizes the current requirements. Fulfilling this yearly requirement consists of i) presenting a seminar based on their dissertation research at least once per year, ii) attending seminars by other BMS students, outside speakers, and faculty and iii) providing feedback regarding content and presentation of the seminars. Providing this feedback further develops the communication skills and scientific interaction that play critical roles in a successful career in science. Note that it is anticipated that Ph.D. students will graduate in approximately 5 to 5.5 years so the stated requirement for these students is 5 credits of BMS 590. In contrast, M.D./Ph.D. students typically spend 4 years in the Ph.D. portion of their joint degree program so the stated requirement for these students is 4 credits of BMS 590.

3) Addition of a requirement for a first-author publication accepted or published based on the student’s dissertation research prior to the final oral examination. Addition of this requirement emphasizes the importance of publications in advancing a career in biomedical sciences. The importance of publications was recently reinforced when a reviewer of a
graduate fellowship application from one of our BMS graduate students wrote that a requirement for only one publication was a weakness of the BMS Graduate Program.

II. Overview of Program Changes: Side-by-Side Comparison

Tables 1-5 show the changes in the curriculum for students to receive the Ph.D. degree from the BMS Graduate Program and its four Options. Tables 6-10 show these changes for students to receive the M.S. degree. Table 11 shows these changes for students to receive the M.D./Ph.D. joint degree.

Consistent with Graduate Council policy, each Option has at least one-quarter of the credits in common with the ‘base program’ and these are shown in the turquoise-shaded cells of the tables. Thus, these cells are identical in Tables 1 through 5 and Tables 6 through 10. In addition, each Option has at least one-third of its credits from option-specific courses as required by Graduate Council policy.

Attachments A1 to C2 show these changes in a different format. These are the curricular tables from the BMS Student Handbook. Attachment A1 shows the curricular requirements for the Ph.D. degree when the BMS Graduate Program was first approved, while Attachment A2 shows the curricular requirements being proposed in this Program Change. Attachments B1 and B2 show these same items for the M.S. degree, while Attachments C1 and C2 show these items for the M.D./Ph.D. joint-degree program.
Table 1: Curriculum to receive the Ph.D. degree in the BMS Graduate Program

<table>
<thead>
<tr>
<th>Current curriculum for the Ph.D. degree in the BMS Graduate Program (30 total credits: 13 “base program” credits; 10 BMS-required credits; 7 elective credits)</th>
<th>Proposed curriculum for the Ph.D. degree in the BMS Graduate Program (29 total credits: 17 “base program” credits; 2 BMS-required credits; 10 elective credits)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course number; title (credits)</td>
<td>Course number; title (credits)</td>
</tr>
<tr>
<td>• BMS 501 Regulation of Cellular and Systemic Energy Metabolism (3)</td>
<td>• BMS 502 Cell and Systems Biology (3)</td>
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<td>• BMS 502 Cell and Systems Biology (3)</td>
<td>• BMS 503 Flow of Cellular Information (3)</td>
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<tr>
<td>• BMS 503 Flow of Cellular Information (3)</td>
<td>• BMS 504 Art of Scientific Communication I (1)</td>
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<tr>
<td>• BMS 504 Art of Scientific Communication I (1)</td>
<td>• BMS 505 Art of Scientific Communication II (1)</td>
</tr>
<tr>
<td>• BMS 505 Art of Scientific Communication II (1)</td>
<td>• BMS 591 Biomedical Research Ethics (1)</td>
</tr>
<tr>
<td>• BMS 591 Biomedical Research Ethics (1)</td>
<td>• BMS 596 Individual Studies Research Rotation (2)</td>
</tr>
<tr>
<td>• BMS 596 Individual Studies Research Rotation (1)</td>
<td>• BMS 801 Writing Grant Proposals for Biomedical Research (1)</td>
</tr>
<tr>
<td>• BMS 520 Human Integrative Physiology (3)</td>
<td>• BMS 590 Colloquium (5); one credit each Spring semester</td>
</tr>
<tr>
<td>• BMS 581 Molecular and Translational Approaches to Human Disease (3)</td>
<td>• Students choose among the following based on their specific interests (2 credits total)</td>
</tr>
<tr>
<td>• BMS 590 Colloquium (2)</td>
<td>• BCHEM 590 Colloquium</td>
</tr>
<tr>
<td></td>
<td>• PSIO 501 Scientific Analysis and Presentation</td>
</tr>
<tr>
<td></td>
<td>• PHARM 590 Colloquium</td>
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<td></td>
<td>• MICRO 590 Colloquium</td>
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<tr>
<td></td>
<td>• MICRO 572 Virology Literature Reports</td>
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<td></td>
<td>• NEURO 590 Colloquium</td>
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<td></td>
<td>OR</td>
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<td></td>
<td>• VIRIM 580 Critical Reading in Immunobiology</td>
</tr>
<tr>
<td>• BMS 596 Individual Studies Research Rotation (2)</td>
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<td>•</td>
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<tr>
<td>• Electives: (7)</td>
<td>• Electives: (10)</td>
</tr>
</tbody>
</table>

**Table legend:** Course or credit requirements in **RED font** are being deleted or changed. Course or credit requirements in **GREEN font** are being added or changed. Courses and credits in **BLACK font** remain unchanged. Courses in **TURQUOISE shaded** boxes are required for all students to receive a Ph.D. in the BMS Graduate Program (“base program” required credits). It is anticipated that Ph.D. students will graduate in approximately 5 to 5.5 years so the stated requirement for these students is 5 credits of BMS 590.
### Table 2: Curriculum to receive the Ph.D. degree in the BMS Graduate Program with the Option in Biochemistry and Molecular Genetics (BMG)

<table>
<thead>
<tr>
<th>Current curriculum for the Ph.D. degree in the BMS Graduate Program (30 total credits: 13 “base program” credits; 8 BMG-required credits; 7 elective credits)</th>
<th>Proposed curriculum for the Ph.D. degree in the BMS Graduate Program with the Option in BMG (29 total credits: 17 “base program” credits; 10 BMG-required credits; 2 elective credits)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Course number; title (credits)</strong></td>
<td><strong>Course number; title (credits)</strong></td>
</tr>
<tr>
<td>• <strong>BMS 501</strong> Regulation of Cellular and Systemic Energy Metabolism (3)</td>
<td>• <strong>BMS 502</strong> Cell and Systems Biology (3)</td>
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<tr>
<td>• BMS 502 Cell and Systems Biology (3)</td>
<td>• BMS 503 Flow of Cellular Information (3)</td>
</tr>
<tr>
<td>• BMS 503 Flow of Cellular Information (3)</td>
<td>• BMS 504 Art of Scientific Communication I (1)</td>
</tr>
<tr>
<td>• BMS 504 Art of Scientific Communication I (1)</td>
<td>• BMS 505 Art of Scientific Communication II (1)</td>
</tr>
<tr>
<td>• BMS 505 Art of Scientific Communication II (1)</td>
<td>• BMS 591 Biomedical Research Ethics (1)</td>
</tr>
<tr>
<td>• BMS 591 Biomedical Research Ethics (1)</td>
<td>• BMS 596 Individual Studies Research Rotation (1)</td>
</tr>
<tr>
<td>• <strong>BMS 596</strong> Individual Studies Research Rotation (1)</td>
<td>• BCHEM 521 Structure, Function, and Regulation of Biological Molecules (3)</td>
</tr>
<tr>
<td>• <strong>BCHEM 521</strong> Structure, Function, and Regulation of Biological Molecules (3)</td>
<td>• BCHEM 522 Molecular Genetics: Genes to Genomes (3)</td>
</tr>
<tr>
<td>• <strong>BCHEM 522</strong> Molecular Genetics: Genes to Genomes (3)</td>
<td>• BMS 512 Data Analysis for the Biomedical Laboratory Scientist: A Practical Approach (2)</td>
</tr>
<tr>
<td>• <strong>BCHEM 590</strong> Colloquium (2)</td>
<td>• BCHEM 590 Colloquium (2)</td>
</tr>
<tr>
<td>• <strong>BCHEM 596</strong> Individual Studies Research Rotation (2)</td>
<td>• Electives: (7)</td>
</tr>
<tr>
<td>• Electives: (7)</td>
<td>• Electives: (2)</td>
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</tbody>
</table>

**Table legend:** See legend for Table 1
Table 3: Curriculum to receive the Ph.D. degree in the BMS Graduate Program with the Option in Cellular and Integrative Physiology (CIP)

<table>
<thead>
<tr>
<th>Course number; title (credits)</th>
<th>Course number; title (credits)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• BMS 502 Cell and Systems Biology (3)</td>
<td>• PSIO 504 Cellular and Integrative Physiology (3)</td>
</tr>
<tr>
<td>• BMS 503 Flow of Cellular Information (3)</td>
<td>• PSIO 505 Cellular and Integrative Physiology II (3)</td>
</tr>
<tr>
<td>• BMS 504 Art of Scientific Communication I (1)</td>
<td>• BMS 581 Molecular and Translational Approaches to Human Disease (3)</td>
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<tr>
<td>• BMS 505 Art of Scientific Communication II (1)</td>
<td>• PSIO 501 Scientific Analysis and Presentation (2)</td>
</tr>
<tr>
<td>• BMS 591 Biomedical Research Ethics (1)</td>
<td>• Electives: (1)</td>
</tr>
<tr>
<td>• BMS 596 Individual Studies Research Rotation (2)</td>
<td></td>
</tr>
<tr>
<td>• BMS 801 Writing Grant Proposals for Biomedical Research (1)</td>
<td></td>
</tr>
<tr>
<td>• BMS 590 Colloquium (5); one credit each Spring semester</td>
<td></td>
</tr>
</tbody>
</table>

**Table legend:** See legend for Table 1
Table 4: Curriculum to receive the Ph.D. degree in the BMS Graduate Program with the Option in Translational Therapeutics (TT)

<table>
<thead>
<tr>
<th>Current curriculum for the Ph.D. degree in the BMS Graduate Program (30 total credits: 13 “base program” credits; 10 TT-required credits; 7 elective credit)</th>
<th>Proposed curriculum for the Ph.D. degree in the BMS Graduate Program with the Option in TT (29 total credits: 17 “base program” credits; 11 TT-required credits; 1 elective credit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course number; title (credits)</td>
<td>Course number; title (credits)</td>
</tr>
<tr>
<td>• <strong>BMS 501</strong> Regulation of Cellular and Systemic Energy Metabolism (3)</td>
<td>• <strong>BMS 502</strong> Cell and Systems Biology (3)</td>
</tr>
<tr>
<td>• <strong>BMS 502</strong> Cell and Systems Biology (3)</td>
<td>• <strong>BMS 503</strong> Flow of Cellular Information (3)</td>
</tr>
<tr>
<td>• <strong>BMS 503</strong> Flow of Cellular Information (3)</td>
<td>• <strong>BMS 504</strong> Art of Scientific Communication I (1)</td>
</tr>
<tr>
<td>• <strong>BMS 504</strong> Art of Scientific Communication I (1)</td>
<td>• <strong>BMS 505</strong> Art of Scientific Communication II (1)</td>
</tr>
<tr>
<td>• <strong>BMS 505</strong> Art of Scientific Communication II (1)</td>
<td>• <strong>BMS 591</strong> Biomedical Research Ethics (1)</td>
</tr>
<tr>
<td>• <strong>BMS 591</strong> Biomedical Research Ethics (1)</td>
<td>• <strong>BMS 596</strong> Individual Studies Research Rotation (2)</td>
</tr>
<tr>
<td>• <strong>BMS 596</strong> Individual Studies Research Rotation (1)</td>
<td>• <strong>BMS 801</strong> Writing Grant Proposals for Biomedical Research (1)</td>
</tr>
<tr>
<td>• <strong>PHARM 520</strong> Principles of Drug Action (2)</td>
<td>• <strong>PHARM 590</strong> Colloquium (5); one credit each Spring semester</td>
</tr>
<tr>
<td>• <strong>PHARM 551</strong> Anti-infective Therapeutics (1)</td>
<td>• <strong>PHARM 552</strong> Integrated Systems Pharmacology (1)</td>
</tr>
<tr>
<td>• <strong>PHARM 552</strong> Integrated Systems Pharmacology (1)</td>
<td>• <strong>PHARM 553</strong> Gastrointestinal and Immunomodulatory Therapeutics (1)</td>
</tr>
<tr>
<td>• <strong>PHARM 553</strong> Gastrointestinal and Immunomodulatory Therapeutics (1)</td>
<td>• <strong>PHARM 554</strong> Anticancer Therapeutics (1)</td>
</tr>
<tr>
<td>• <strong>PHARM 554</strong> Anticancer Therapeutics (1)</td>
<td>• <strong>PHARM 561</strong> Neuropharmacology (2)</td>
</tr>
<tr>
<td>• <strong>PHARM 561</strong> Neuropharmacology (2)</td>
<td>• <strong>PHARM 562</strong> Endocrine Pharmacology (2)</td>
</tr>
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<td>• <strong>PHARM 562</strong> Endocrine Pharmacology (2)</td>
<td>• <strong>BCHEM 596</strong> Individual Studies Research Rotation (2)</td>
</tr>
<tr>
<td>• <strong>Electives:</strong> (7)</td>
<td>• <strong>Electives:</strong> (1)</td>
</tr>
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</table>

Table legend: See legend for Table 1
Table 5: Curriculum to receive the Ph.D. degree in the BMS Graduate Program with the Option in Virology and Immunology (VIRIM)

<table>
<thead>
<tr>
<th>Current curriculum for the Ph.D. degree in the BMS Graduate Program (33 total credits: 13 “base program” credits; 20 VIRIM-required credits)</th>
<th>Proposed curriculum for the Ph.D. degree in the BMS Graduate Program with the Option in VIRIM (29 total credits: 17 “base program” credits; 11 VIRIM-required credits; 1 elective credit)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Course number; title (credits)</strong></td>
<td><strong>Course number; title (credits)</strong></td>
</tr>
<tr>
<td>• BMS 501 Regulation of Cellular and Systemic Energy Metabolism (3)</td>
<td>• BMS 502 Cell and Systems Biology (3)</td>
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<td>• BMS 503 Flow of Cellular Information (3)</td>
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<td>• BMS 503 Flow of Cellular Information (3)</td>
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<td>• BMS 504 Art of Scientific Communication I (1)</td>
<td>• BMS 505 Art of Scientific Communication II (1)</td>
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<td>• BMS 591 Biomedical Research Ethics (1)</td>
</tr>
<tr>
<td>• BMS 591 Biomedical Research Ethics (1)</td>
<td>• BMS 596 Individual Studies Research Rotation (2)</td>
</tr>
<tr>
<td>• BMS 596 Individual Studies Research Rotation (1)</td>
<td>• BMS 801 Writing Grant Proposals for Biomedical Research (1)</td>
</tr>
<tr>
<td>• MICRO 550 Medical Microbiology (2)</td>
<td>• BMS 590 Colloquium (5); one credit each Spring semester</td>
</tr>
<tr>
<td>• MICRO 553 Science of Virology (4)</td>
<td>• MICRO 550 Medical Microbiology (2)</td>
</tr>
<tr>
<td>• MICRO 560 Concepts in Immunology (4)</td>
<td>• BMS 564 Concepts in Virology (2); OR</td>
</tr>
<tr>
<td>• MICRO 560 Concepts in Immunology (2)</td>
<td>• MICRO 560 Concepts in Immunology (2)</td>
</tr>
<tr>
<td>• MICRO 581 Immunology A: Basic Concepts in Innate and Adaptive Immunity (1)</td>
<td>• MICRO 581 Immunology A: Basic Concepts in Innate and Adaptive Immunity (1)</td>
</tr>
<tr>
<td>• MICRO 582 Immunology B: Adaptive Immunity (1)</td>
<td>• MICRO 582 Immunology B: Adaptive Immunity (1)</td>
</tr>
<tr>
<td>• MICRO 590 Colloquium (1)</td>
<td>• BMS 562 Principles of Immunology C: Dysfunction and Manipulation of the Immune System (1); OR</td>
</tr>
<tr>
<td>• BCHEM 596 Individual Studies Research Rotation (2)</td>
<td>• BMS 566 Viral Oncogenesis (1)</td>
</tr>
<tr>
<td>• MICRO 602 Supervised Experience in College Teaching (2)</td>
<td>• BMS 567 Viral Pathogenesis (1)</td>
</tr>
<tr>
<td>• MICRO 572 Virology Literature Reports (1) OR</td>
<td>• MICRO 590 Colloquium (1)</td>
</tr>
<tr>
<td>• IBIOS 580 Immunology Journal Club (1)</td>
<td>• MICRO 572 Virology Literature Reports (1); OR</td>
</tr>
<tr>
<td>• GENET 581 Genetics of Model Organisms: Bacterial and Viral Pathogenesis (1)</td>
<td>• VIRIM 580 Critical Reading in Immunobiology (1)</td>
</tr>
<tr>
<td></td>
<td>• GENET 581 Genetics of Model Organisms: Bacterial and Viral Pathogenesis (1)</td>
</tr>
<tr>
<td></td>
<td>• Electives: (1)</td>
</tr>
</tbody>
</table>

Table legend: See legend for Table 1
Table 6: Curriculum to receive the M.S. degree in the BMS Graduate Program

<table>
<thead>
<tr>
<th>Current curriculum for the M.S. degree in the BMS Graduate Program [30 total credits: 13 “base program” credits; 10 BMS-required credits; 6 credits of BMS 600; 1 elective credit]</th>
<th>Proposed curriculum for the M.S. degree in the BMS Graduate Program (32 total credits: 13 “base program” credits; 2 BMS-required credits; 6 credits of BMS 600; 11 elective credits)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course number; title (credits)</td>
<td>Course number; title (credits)</td>
</tr>
<tr>
<td>• BMS 501 Regulation of Cellular and Systemic Energy Metabolism (3)</td>
<td>• BMS 502 Cell and Systems Biology (3)</td>
</tr>
<tr>
<td>• BMS 502 Cell and Systems Biology (3)</td>
<td>• BMS 503 Flow of Cellular Information (3)</td>
</tr>
<tr>
<td>• BMS 503 Flow of Cellular Information (3)</td>
<td>• BMS 504 Art of Scientific Communication I (1)</td>
</tr>
<tr>
<td>• BMS 504 Art of Scientific Communication I (1)</td>
<td>• BMS 505 Art of Scientific Communication II (1)</td>
</tr>
<tr>
<td>• BMS 505 Art of Scientific Communication II (1)</td>
<td>• BMS 591 Biomedical Research Ethics (1)</td>
</tr>
<tr>
<td>• BMS 591 Biomedical Research Ethics (1)</td>
<td>• BMS 596 Individual Studies Research Rotation (2)</td>
</tr>
<tr>
<td>• BMS 596 Individual Studies Research Rotation (1)</td>
<td>• BMS 590 Colloquium (2); one credit each Spring semester</td>
</tr>
<tr>
<td>• BMS 520 Human Integrative Physiology (3)</td>
<td>•</td>
</tr>
<tr>
<td>• BMS 581 Molecular and Translational Approaches to Human Disease (3)</td>
<td>• Students choose among the following based on their specific interests (2 credits total)</td>
</tr>
<tr>
<td>• BMS 590 Colloquium (2)</td>
<td>• BCHEM 590 Colloquium</td>
</tr>
<tr>
<td>• BMS 596 Individual Studies Research Rotation (2)</td>
<td>• PSIO 501 Scientific Analysis and Presentation</td>
</tr>
<tr>
<td>• BMS 600 Thesis Research (6)</td>
<td>• PHARM 590 Colloquium</td>
</tr>
<tr>
<td>• Electives: (1)</td>
<td>• MICRO 590 Colloquium</td>
</tr>
<tr>
<td></td>
<td>• MICRO 572 Virology Literature Reports</td>
</tr>
<tr>
<td></td>
<td>• NEURO 590 Colloquium</td>
</tr>
<tr>
<td></td>
<td>OR</td>
</tr>
<tr>
<td></td>
<td>VIRIM 580 Critical Reading in Immunobiology</td>
</tr>
<tr>
<td></td>
<td>•</td>
</tr>
<tr>
<td></td>
<td>• BMS 600 Thesis Research (6)</td>
</tr>
<tr>
<td></td>
<td>• Electives: (11)</td>
</tr>
</tbody>
</table>

Table legend: Course or credit requirements in **RED font** are being deleted or changed. Course or credit requirements in **GREEN font** are being added or changed. Courses and credits in **BLACK font** remain unchanged. Courses in **TURQUOISE shaded** boxes are required for all students to receive a M.S. in the BMS Graduate Program (“base program” required credits).
### Table 7: Curriculum to receive the M.S. degree in the BMS Graduate Program with the Option in BMG

#### Current curriculum for the M.S. degree in the BMS Graduate Program with the Option in BMG (30 total credits: 13 “base program” credits; 10 BMG-required credits; 6 credits of BMS 600; 1 elective credit)

<table>
<thead>
<tr>
<th>Course number; title (credits)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BMS 501</strong> Regulation of Cellular and Systemic Energy Metabolism (3)</td>
<td></td>
</tr>
<tr>
<td><strong>BMS 502</strong> Cell and Systems Biology (3)</td>
<td></td>
</tr>
<tr>
<td><strong>BMS 503</strong> Flow of Cellular Information (3)</td>
<td></td>
</tr>
<tr>
<td><strong>BMS 504</strong> Art of Scientific Communication I (1)</td>
<td></td>
</tr>
<tr>
<td><strong>BMS 505</strong> Art of Scientific Communication II (1)</td>
<td></td>
</tr>
<tr>
<td><strong>BMS 591</strong> Biomedical Research Ethics (1)</td>
<td></td>
</tr>
<tr>
<td><strong>BMS 596</strong> Individual Studies Research Rotation (1)</td>
<td></td>
</tr>
<tr>
<td><strong>BCHEM 521</strong> Structure, Function, and Regulation of Biological Molecules (3)</td>
<td></td>
</tr>
<tr>
<td><strong>BCHEM 522</strong> Molecular Genetics: Genes to Genomes (3)</td>
<td></td>
</tr>
<tr>
<td><strong>BCHEM 590</strong> Colloquium (2)</td>
<td></td>
</tr>
<tr>
<td><strong>BCHEM 596</strong> Individual Studies Research Rotation (2)</td>
<td></td>
</tr>
<tr>
<td><strong>BMS 600</strong> Thesis Research (6)</td>
<td></td>
</tr>
<tr>
<td><strong>Electives:</strong> (1)</td>
<td></td>
</tr>
</tbody>
</table>

#### Proposed curriculum for the M.S. degree in the BMS Graduate Program with the Option in BMG (32 total credits: 13 “base program” credits; 10 BMG-required credits; 6 credits of BMS 600; 3 elective credits)

<table>
<thead>
<tr>
<th>Course number; title (credits)</th>
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<tbody>
<tr>
<td><strong>BMS 502</strong> Cell and Systems Biology (3)</td>
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<tr>
<td><strong>BMS 503</strong> Flow of Cellular Information (3)</td>
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</tr>
<tr>
<td><strong>BMS 504</strong> Art of Scientific Communication I (1)</td>
<td></td>
</tr>
<tr>
<td><strong>BMS 505</strong> Art of Scientific Communication II (1)</td>
<td></td>
</tr>
<tr>
<td><strong>BMS 591</strong> Biomedical Research Ethics (1)</td>
<td></td>
</tr>
<tr>
<td><strong>BMS 596</strong> Individual Studies Research Rotation (2)</td>
<td></td>
</tr>
<tr>
<td><strong>BMS 599</strong> Colloquium (2); one credit each Spring semester</td>
<td></td>
</tr>
<tr>
<td><strong>BCHEM 521</strong> Structure, Function, and Regulation of Biological Molecules (3)</td>
<td></td>
</tr>
<tr>
<td><strong>BCHEM 522</strong> Molecular Genetics: Genes to Genomes (3)</td>
<td></td>
</tr>
<tr>
<td><strong>BCHEM 590</strong> Colloquium (2)</td>
<td></td>
</tr>
<tr>
<td><strong>BCHEM 596</strong> Individual Studies Research Rotation (2)</td>
<td></td>
</tr>
<tr>
<td><strong>BMS 512</strong> Data Analysis for the Biomedical Laboratory Scientist: A Practical Approach (2)</td>
<td></td>
</tr>
<tr>
<td><strong>BMS 600</strong> Thesis Research (6)</td>
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</tr>
<tr>
<td><strong>Electives:</strong> (3)</td>
<td></td>
</tr>
</tbody>
</table>

**Table legend:** See legend for Table 6
Table 8: Curriculum to receive the M.S. degree in the BMS Graduate Program with the Option in CIP

<table>
<thead>
<tr>
<th>Course number; title (credits)</th>
<th>Course number; title (credits)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• BMS 502 Cell and Systems Biology (3)</td>
<td></td>
</tr>
<tr>
<td>• BMS 503 Flow of Cellular Information (3)</td>
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</tr>
<tr>
<td>• BMS 504 Art of Scientific Communication I (1)</td>
<td></td>
</tr>
<tr>
<td>• BMS 505 Art of Scientific Communication II (1)</td>
<td></td>
</tr>
<tr>
<td>• BMS 591 Biomedical Research Ethics (1)</td>
<td></td>
</tr>
<tr>
<td>• BMS 596 Individual Studies Research Rotation (2)</td>
<td></td>
</tr>
<tr>
<td>• BMS 590 Colloquium (2); one credit each Spring semester</td>
<td></td>
</tr>
<tr>
<td>• PSIO 504 Cellular and Integrative Physiology (3)</td>
<td></td>
</tr>
<tr>
<td>• PSIO 505 Cellular and Integrative Physiology II (3)</td>
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<tr>
<td>• BMS 581 Molecular and Translational Approaches to Human Disease (3)</td>
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</tr>
<tr>
<td>• PSIO 501 Scientific Analysis and Presentation (2)</td>
<td></td>
</tr>
<tr>
<td>• BMS 600 Thesis Research (6)</td>
<td></td>
</tr>
<tr>
<td>• Electives: (2)</td>
<td></td>
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</tbody>
</table>

Table legend: See legend for Table 6
Table 9: Curriculum to receive the M.S. degree in the BMS Graduate Program with the Option in TT

<table>
<thead>
<tr>
<th>Current curriculum for the M.S. degree in the BMS Graduate Program with the Option in TT (30 total credits: 13 “base program” credits; 10 TT-required credits; 6 credits of BMS 600; 1 elective credit)</th>
<th>Proposed curriculum for the M.S. degree in the BMS Graduate Program with the Option in TT (32 total credits: 13 “base program” credits; 11 TT-required credits; 6 credits of BMS 600; 2 elective credits)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course number; title (credits)</td>
<td>Course number; title (credits)</td>
</tr>
<tr>
<td>• <strong>BMS 501</strong> Regulation of Cellular and Systemic Energy Metabolism (3)</td>
<td>• <strong>BMS 502</strong> Cell and Systems Biology (3)</td>
</tr>
<tr>
<td>• BMS 502 Cell and Systems Biology (3)</td>
<td>• BMS 503 Flow of Cellular Information (3)</td>
</tr>
<tr>
<td>• BMS 503 Flow of Cellular Information (3)</td>
<td>• BMS 504 Art of Scientific Communication I (1)</td>
</tr>
<tr>
<td>• BMS 504 Art of Scientific Communication I (1)</td>
<td>• BMS 505 Art of Scientific Communication II (1)</td>
</tr>
<tr>
<td>• BMS 505 Art of Scientific Communication II (1)</td>
<td>• BMS 591 Biomedical Research Ethics (1)</td>
</tr>
<tr>
<td>• BMS 591 Biomedical Research Ethics (1)</td>
<td>• <strong>BMS 590</strong> Colloquium (2); one credit each Spring semester</td>
</tr>
<tr>
<td>• <strong>BMS 596</strong> Individual Studies Research Rotation (1)</td>
<td>• <strong>BMS 596</strong> Individual Studies Research Rotation (2)</td>
</tr>
<tr>
<td>• PHARM 520 Principles of Drug Action (2)</td>
<td>• PHARM 520 Principles of Drug Action (2)</td>
</tr>
<tr>
<td>• PHARM 551 Anti-infective Therapeutics (1)</td>
<td>• PHARM 551 Anti-infective Therapeutics (1)</td>
</tr>
<tr>
<td>• PHARM 552 Integrated Systems Pharmacology (1)</td>
<td>• PHARM 552 Integrated Systems Pharmacology (1)</td>
</tr>
<tr>
<td>• PHARM 553 Gastrointestinal and Immunomodulatory Therapeutics (1)</td>
<td>• PHARM 553 Gastrointestinal and Immunomodulatory Therapeutics (1)</td>
</tr>
<tr>
<td>• PHARM 554 Anticancer Therapeutics (1)</td>
<td>• PHARM 554 Anticancer Therapeutics (1)</td>
</tr>
<tr>
<td>• PHARM 561 Neuropharmacology (2)</td>
<td>• PHARM 561 Neuropharmacology (2)</td>
</tr>
<tr>
<td>• PHARM 562 Endocrine Pharmacology (2)</td>
<td>• PHARM 562 Endocrine Pharmacology (2)</td>
</tr>
<tr>
<td>• PHARM 590 Colloquium (2)</td>
<td>• PHARM 590 Colloquium (1)</td>
</tr>
<tr>
<td>• BMS 600 Thesis Research (6)</td>
<td>• <strong>BMS 600</strong> Thesis Research (6)</td>
</tr>
<tr>
<td>• BCHEM 596 Individual Studies Research Rotation (2)</td>
<td>• Electives: (2)</td>
</tr>
<tr>
<td>• Electives: (1)</td>
<td>• Electives: (2)</td>
</tr>
</tbody>
</table>

Table legend: See legend for Table 6
Table 10: Curriculum to receive the M.S. degree in the BMS Graduate Program with the Option in VIRIM

<table>
<thead>
<tr>
<th>Current curriculum for the M.S. degree in the BMS Graduate Program with the Option in VIRIM (38 total credits: 13 “base program” credits; 19 VIRIM-required credits; 6 credits of BMS 600)</th>
<th>Proposed curriculum for the M.S. degree in the BMS Graduate Program with the Option in VIRIM (32 total credits: 13 “base program” credits; 11 VIRIM-required credits; 6 credits of BMS 600; 2 elective credits)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Course number; title (credits)</strong></td>
<td><strong>Course number; title (credits)</strong></td>
</tr>
<tr>
<td>• BMS 501 Regulation of Cellular and Systemic Energy Metabolism (3)</td>
<td>• BMS 502 Cell and Systems Biology (3)</td>
</tr>
<tr>
<td>• BMS 502 Cell and Systems Biology (3)</td>
<td>• BMS 503 Flow of Cellular Information (3)</td>
</tr>
<tr>
<td>• BMS 503 Flow of Cellular Information (3)</td>
<td>• BMS 504 Art of Scientific Communication I (1)</td>
</tr>
<tr>
<td>• BMS 504 Art of Scientific Communication I (1)</td>
<td>• BMS 505 Art of Scientific Communication II (1)</td>
</tr>
<tr>
<td>• BMS 505 Art of Scientific Communication II (1)</td>
<td>• BMS 591 Biomedical Research Ethics (1)</td>
</tr>
<tr>
<td>• BMS 591 Biomedical Research Ethics (1)</td>
<td>• BMS 596 Individual Studies Research Rotation (2)</td>
</tr>
<tr>
<td>• BMS 596 Individual Studies Research Rotation (1)</td>
<td>• BMS 590 Colloquium (2); one credit each Spring semester</td>
</tr>
<tr>
<td></td>
<td>• MICRO 550 Medical Microbiology (2)</td>
</tr>
<tr>
<td>• MICRO 550 Medical Microbiology (2)</td>
<td>• MICRO 553 Science of Virology (4)</td>
</tr>
<tr>
<td>• MICRO 553 Science of Virology (4)</td>
<td>• MICRO 564 Concepts in Virology (2)</td>
</tr>
<tr>
<td>• MICRO 560 Concepts in Immunology (4)</td>
<td>• MICRO 560 Concepts in Immunology (2)</td>
</tr>
<tr>
<td>• MICRO 561 Immunology A: Basic Concepts in Innate and Adaptive Immunity (1)</td>
<td>• MICRO 581 Immunology A: Basic Concepts in Innate and Adaptive Immunity (1)</td>
</tr>
<tr>
<td>• MICRO 581 Immunology A: Basic Concepts in Innate and Adaptive Immunity (1)</td>
<td>• MICRO 582 Immunology B: Adaptive Immunity (1)</td>
</tr>
<tr>
<td>• MICRO 582 Immunology B: Adaptive Immunity (1)</td>
<td>• BMS 562 Principles of Immunology C Dysfunction and Manipulation of the Immune System (1)</td>
</tr>
<tr>
<td>• MICRO 580 Colloquium (1)</td>
<td>OR</td>
</tr>
<tr>
<td>• BCHEM 596 Individual Studies Research Rotation (2)</td>
<td>• BMS 566 Viral Oncogenesis (1)</td>
</tr>
<tr>
<td>• MICRO 602 Supervised Experience in College Teaching (2)</td>
<td>• BMS 567 Viral Pathogenesis (1)</td>
</tr>
<tr>
<td>• MICRO 572 Virology Literature Reports (1)</td>
<td>• MICRO 590 Colloquium (1)</td>
</tr>
<tr>
<td>OR</td>
<td>• MICRO 572 Virology Literature Reports (1)</td>
</tr>
<tr>
<td>• IBIOS 580 Immunology Journal Club (1)</td>
<td>OR</td>
</tr>
<tr>
<td>• GENET 581 Genetics of Model Organisms: Bacterial and Viral Pathogenesis (1)</td>
<td>• VIRIM 580 Critical Reading in Immunobiology (1)</td>
</tr>
<tr>
<td>• BMS 600 Thesis Research (6)</td>
<td>• GENET 581 Genetics of Model Organisms: Bacterial and Viral Pathogenesis (1)</td>
</tr>
<tr>
<td></td>
<td>• BMS 600 Thesis Research (6)</td>
</tr>
<tr>
<td></td>
<td>• Electives: (2)</td>
</tr>
</tbody>
</table>

Table legend: See legend for Table 6
Table 11: Curriculum to receive the Ph.D. degree in the joint M.D./Ph.D. degree program from the BMS Graduate Program

<table>
<thead>
<tr>
<th>Current curriculum for the Ph.D. degree in the joint M.D./Ph.D. degree program in the BMS Graduate Program (24 total credits: 15 “base program” credits; 5 BMS-required credits; 4 elective credits)</th>
<th>Proposed curriculum for the Ph.D. degree in the joint M.D./Ph.D. degree program in the BMS Graduate Program (28 total credits: 14 “base program” credits; 6 M.D./Ph.D.-required credits; 2 BMS-required credits; 6 elective credits)</th>
</tr>
</thead>
<tbody>
<tr>
<td>course number; title (credits)</td>
<td>course number; title (credits)</td>
</tr>
<tr>
<td>• Basic science information from the medical curriculum replace the following courses and counts as 12 credits</td>
<td>• Basic science information from the medical curriculum replace the following courses and counts as 8 credits</td>
</tr>
<tr>
<td>• BMS 501 Regulation of Cellular and Systemic Energy Metabolism (3)</td>
<td>• BMS 502 Cell and Systems Biology (3)</td>
</tr>
<tr>
<td>• BMS 502 Cell and Systems Biology (3)</td>
<td>• BMS 503 Flow of Cellular Information (3)</td>
</tr>
<tr>
<td>• BMS 503 Flow of Cellular Information (3)</td>
<td>• BMS 506A Biological Basis of Health and Disease A (2)</td>
</tr>
<tr>
<td>• BMS 596 Individual Studies Research Rotation (1)</td>
<td>• BMS 506B Biological Basis of Health and Disease B (2)</td>
</tr>
<tr>
<td>• BMS 504 Art of Scientific Communication I (1)</td>
<td>• BMS 512 Data Analysis for the Biomedical Laboratory Scientist: A Practical Approach (2)</td>
</tr>
<tr>
<td>• BMS 505 Art of Scientific Communication II (1)</td>
<td>• BMS 591 Biomedical Research Ethics (1)</td>
</tr>
<tr>
<td>• BMS 590 Biomedical Research Ethics (1)</td>
<td>• BMS 801 Writing Grant Proposals for Biomedical Research (1)</td>
</tr>
<tr>
<td>• BMS 581 Molecular and Translational Approaches to Human Disease (3)</td>
<td>• BMS 590 Colloquium (4); one credit each Spring semester</td>
</tr>
<tr>
<td>• BMS 590 Colloquium (2)</td>
<td>• BCHEM 590 Colloquium</td>
</tr>
<tr>
<td></td>
<td>• PSIO 501 Scientific Analysis and Presentation</td>
</tr>
<tr>
<td></td>
<td>• PHARM 590 Colloquium</td>
</tr>
<tr>
<td></td>
<td>• MICRO 590 Colloquium</td>
</tr>
<tr>
<td></td>
<td>• MICRO 572 Virology Literature Reports</td>
</tr>
<tr>
<td></td>
<td>• NEURO 590 Colloquium</td>
</tr>
<tr>
<td></td>
<td>• VIRIM 580 Critical Reading in Immunobiology</td>
</tr>
<tr>
<td>Students choose among the following based on their specific interests (2 credits total)</td>
<td></td>
</tr>
</tbody>
</table>
**Table legend:** Course or credit requirements in **RED font** are being deleted or changed. Course or credit requirements in **GREEN font** are being added or changed. Courses and credits in **BLACK font** remain unchanged. Courses in **TURQUOISE shaded** boxes are required for all students to receive a Ph.D. in the BMS Graduate Program (“base program” required credits). Courses in **GRAY shaded** boxes are required for all students to receive a Ph.D. in the joint M.D./Ph.D. degree program from the BMS Graduate Program. M.D./Ph.D. students typically spend 4 years in the Ph.D. portion of their joint degree program so the stated requirement for these students is 4 credits of BMS 590.
III. Proposed Graduate Bulletin Text

Biomedical Sciences (BMS)

Program Home Page
PROFESSOR RALPH L. KEIL, Chair, Biomedical Sciences Graduate Program
The Pennsylvania State University College of Medicine, Mail Code H133
500 University Dr. P.O. Box 850
Hershey, PA 17033
1-717-531-1045
1-717-531-0388 (FAX)
rkeil@psu.edu

Degrees conferred:
Ph.D., M.D./Ph.D., M.S.
Dual-Title Ph.D. (Biomedical Sciences and Clinical and Translational Sciences)

The Graduate Faculty

The Program
The Biomedical Sciences (BMS) Graduate Program with its Options in Biochemistry and Molecular Genetics, Cellular and Integrative Physiology, Translational Therapeutics, and Virology and Immunology provides students curricular training with a unique focus on human health and disease, and the opportunity to concentrate in one or more disciplinary approaches, including biochemistry, biophysics, cell biology, genetics, immunology, 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 industry, education, intellectual property development, technology licensing, journalism, entrepreneurship, and public policy.

The BMS Graduate Program is an interdepartmental program that engages faculty from numerous 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.

Ph.D. Admission Requirements

Admission requirements listed here are in addition to requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.

1. Submission of online Penn State Graduate School application and payment of nonrefundable application fee
2. Graduate Record Examinations (GRE) general test scores
3. Three letters of recommendation
4. Statement of goals including a) reasons for applying to the BMS Graduate Program, b) previous research experiences, c) particular areas of research interests if known, and d) long-term career goals
5. Official transcripts from all post-secondary institutions attended; Note that post-secondary course work should include biochemistry and molecular biology or genetics.
M.D./Ph.D. Admission Requirements
Prospective students interested in simultaneously pursuing a 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. Applicants must also meet the admission requirements of the Graduate School and the Ph.D. admission requirements listed above, however, GRE scores are not required. The M.D./Ph.D. Admissions Committee reviews applications and evaluates candidates for acceptance into both the M.D. and Ph.D. programs. After the review committee has accepted an applicant to the joint degree program, s/he must apply to the Graduate School for admission to the graduate program. Students must be admitted to the joint degree program prior to taking the first course they intend to count towards the graduate degree. Applicants not accepted into the joint-degree program may be referred to either the M.D. or Ph.D. program, depending on their qualifications.

Applicants to this program generally have very strong grades and MCAT scores, as well as a strong and sustained background in research. Applicants must be able to clearly articulate reasons for pursuing the joint degree. Letters of recommendation from faculty who have advised the applicant in research and who can comment on the applicant's passion and potential for research are strongly encouraged.

Dual-Title Ph.D. Degree in Biomedical Sciences and Clinical and Translational Sciences Admission Requirements
Potential dual-title students can express an interest in the dual-title program as early as during the recruitment process for the BMS Graduate Program. Students must apply and be admitted to the graduate program in BMS and the Graduate School before they can apply for admission to the dual-title Ph.D. in Clinical and Translational Sciences (CTS). Refer to the Admission Requirements section of the Clinical and Translational Sciences Bulletin page. Students must apply and be admitted to the dual-title program in CTS prior to taking the candidacy exam.

Degree Requirements
Lisa Shantz, Ph.D., BMS Director
The Pennsylvania State University College of Medicine
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Master's Degree Requirements
Although the BMS Graduate Program awards M.S. degrees, it does not actively recruit students to earn M.S. degrees.

Requirements listed here are in addition to requirements stated in the DEGREE REQUIREMENTS section of the Graduate Bulletin.

To receive the M.S. degree in BMS, at least 32 credits from courses at the 400, 500, 600, and 800 level are required.

1 Required BMS Core Courses (13 cr.): BMS 502 Cell and Systems Biology and BMS 503 Flow of Cellular Information (6 cr.), BMS 504 and BMS 505 Art of Scientific Communication I and II (2 cr.), BMS 590 Colloquium (2 cr.), BMS 591 Biomedical Research Ethics (1 cr.), and BMS 596 Individual Studies: Research Rotation (2 cr.).
2. **Required Program Courses (13 cr.):** Colloquium or Journal Club fulfilled by taking 2 credits of any of the following: BCHEM 590 Colloquium, PSIO 501 Scientific Analysis and Presentation, PHARM 590 Colloquium, MICRO 590 Colloquium, MICRO 572 Virology Literature Reports, NEURO 590 Colloquium, or VIRIM 580 Critical Reading in Immunobiology, and at least 11 credits of elective courses at the 500 or 800 level, selected in consultation with the student's thesis adviser and thesis committee.

3. **Thesis Research (6 cr.):** BMS 600 Thesis Research (6 cr.). No more than 6 credits of BMS 600 Thesis Research may be counted toward the 32 credit minimum. Students must complete original laboratory research that culminates in a thesis. The thesis must be accepted by the master's committee, the chair of the graduate program, and the Graduate School.

Each candidate for the M.S. degree must fulfill written and spoken English communication requirements that are satisfied by preparing written and oral reports describing the laboratory rotations during the first year.

**Doctoral Degree Requirements**

Requirements listed here are in addition to requirements stated in the DEGREE REQUIREMENTS section of the Graduate Bulletin.

To receive the Ph.D. degree in Biomedical Sciences, at least 29 credits from courses at the 400, 500, 600, and 800 level are required.

1. **Required BMS Core Courses (17 cr.):** BMS 502 Cell and Systems Biology and BMS 503 Flow of Cellular Information (6 cr.); BMS 504 and 505 Art of Scientific Communication I and II (2 cr.), BMS 590 Colloquium (5 cr.), BMS 591 Biomedical Research Ethics (1 cr.), BMS 596 Individual Study: Research (2 cr.), BMS 801 Writing Grant Proposals for Biomedical Research (1 cr.).

2. **Required Program Courses (12 cr.):** 2 credits of Colloquium or Journal Club fulfilled by taking any of the following: BCHEM 590 Colloquium, PSIO 501 Scientific Analysis and Presentation, PHARM 590 Colloquium, MICRO 590 Colloquium, MICRO 572 Virology Literature Reports, NEURO 590 Colloquium, or VIRIM 580 Critical Reading in Immunobiology, and at least 10 credits of elective courses at the 500 or 800 level, selected in consultation with the student's dissertation adviser and doctoral committee.

Each candidate for the Ph.D. degree must fulfill written and spoken English communication requirements that are satisfied by preparing written and oral reports describing the laboratory rotations during the first year.

The first-year Fall curriculum provides the student an understanding of basic cellular processes through a core curriculum that includes two integrated three-credit courses: Flow of Cellular Information and Cell and Systems Biology. These courses develop concepts related to genome structure and function, regulation of gene expression, regulation of energy supply and demand, cellular and subcellular structures, cell-to-cell signaling, and the organization and function of cells in multicellular systems. The Fall curriculum also includes the one-credit Art of Scientific Communication I course that reinforces concepts developed in the integrated courses and aids students in the transition from textbooks to primary literature as a source of information.

The first-year Spring curriculum offers an opportunity to explore one or more curricular paths that lead to entry into one of the Options or to design an individualized curricular path within the BMS Graduate Program. The Spring curriculum also includes the one-credit Art of Scientific Communication II course that further develops the student's knowledge acquisition from the primary literature and assists improvement of presentation and writing skills necessary for subsequent journal clubs, literature-based courses, and scientific learning and discourse throughout their career.
In addition, students complete at least three research rotations during the first year that expose them to the wide range of research interests of the Penn State 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 a dissertation adviser and doctoral committee.

Curriculum in the second year is determined by the choice to participate in one of the Options, or an individualized curricular path designed by the student in consultation with the dissertation adviser and doctoral committee.

All doctoral students must pass a candidacy examination, a comprehensive examination, and a final oral examination (the dissertation defense). At the end of the first year, admission to Ph.D. candidacy is determined by performance in course work, laboratory rotations, and the BMS Graduate Program Candidacy Examination. Students join their research laboratory by the end of the summer of the first year.

Ph.D. candidates prepare a written comprehensive examination in the format of a grant application prior to the end of the fifth semester of enrollment. As part of this examination, the candidate also gives an oral presentation of this proposal to their doctoral committee.

To earn the Ph.D. degree, doctoral students must write a dissertation that is accepted by the doctoral committee, the chair of the graduate program, and the Graduate School. Students are required to have at least one first-author publication accepted or published based on their dissertation research prior to the final oral examination. A student may petition the Chair of the BMS Graduate Program 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.

**Dual-Title Doctoral Degree Requirements**

To qualify for the dual-title degree in Biomedical Sciences and Clinical and Translational Sciences, students must satisfy the BMS Ph.D. degree requirements listed in the “Doctoral Degree Requirements” section above. In addition, students pursuing the dual-title Ph.D. in BMS and CTS must complete the degree requirements for the dual-title CTS Ph.D., listed on the CTS Bulletin page. Up to 7 credits for the Ph.D. degree in BMS that overlap with the CTS elective requirements can be counted toward the CTS dual-title.

The choice of CTS electives is subject to approval by the student’s academic adviser(s) from the BMS and CTS programs. The electives should complement the student's work in BMS. A list of approved electives is maintained by the CTS program office.

The candidacy examination contains elements of both BMS and CTS. In accordance with Graduate Council policy, the candidacy committee must include at least one member of the CTS Graduate Faculty. Faculty with graduate appointments in both programs may serve in a combined role. Dual-title graduate degree students may require an additional semester to fulfill requirements for both areas of study and, therefore, the candidacy examination may be delayed one semester beyond the normal period allowable.

The doctoral committee must include at least one member of the CTS Graduate Faculty. Faculty members who hold appointments in the Graduate Faculty of both programs may serve in a combined role. If the chair of the doctoral committee is not a member of the Graduate Faculty in CTS, the member of the committee representing CTS must be appointed as co-chair. The fields of BMS and CTS will be integrated in the student’s comprehensive exam, and the doctoral committee member representing CTS is responsible for insuring coverage of information relevant to the CTS field of study.
The candidate must complete a dissertation on a topic that reflects their original research and education in both BMS and CTS. To earn the dual-title Ph.D. degree, the dissertation must be accepted by the doctoral committee, the chair of the graduate program, and the Graduate School, and the student must pass a final oral examination (the dissertation defense).

OPTIONS

The Options offered within the BMS Graduate Program provide the student a curricular specialization focused on different approaches to biomedical research.

BIOCHEMISTRY AND MOLECULAR GENETICS (BMG) OPTION

John M. Flanagan, Ph.D., Option Director
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The objective of the BMG Option is to provide course work and laboratory training that focus on the principles and application of biochemical and molecular genetic analysis. These approaches play key roles in identifying and characterizing cellular processes and elucidating the structure and function of key macromolecules including DNA, RNA, proteins, lipids, and carbohydrates. The Option also stresses the biological intersections of these classes of macromolecules. The combination of didactic courses, colloquia, seminars, and laboratory research provides students with an integrated approach for applying biochemical and molecular genetic analyses to interrogate and manipulate basic cellular processes and macromolecules of biomedical significance. The training afforded by this Option exposes graduates to the fundamentals needed to experimentally address scientific questions in areas such as epigenetic control of gene expression, structure/function, biomolecular engineering, and systems analysis using genetic and biochemical approaches.

Admission Requirements for the BMG Option
To be admitted to the BMG Option, students must successfully complete 1) the first year of the BMS Graduate Program, and 2) three research rotations, at least two with faculty in the BMG Option.

Curricular Requirements for the M.S. degree in the BMG Option
In addition to the 13 credits of required BMS Core Courses for the M.S. degree and 6 credits of thesis research, students pursuing the M.S. degree in the BMG Option must take BCHEM 521 Structure, Function, and Regulation of Biological Molecules (3 cr.), BCHEM 522 Molecular Genetics: Genes to Genomes (3 cr.), BCHEM 590 Colloquium (2 cr.), BMS 512 Data Analysis for the Biomedical Lab Scientist (2 cr.), and at least 3 credits of 500-level elective courses selected in consultation with the student's thesis adviser and thesis committee.

Curricular Requirements for the Ph.D. degree in the BMG Option
In addition to the 17 credits of required BMS Core Courses for the Ph.D. degree, students pursuing the Ph.D. degree in the BMG Option must take BCHEM 521 Structure, Function, and Regulation of Biological Molecules (3 cr.), BCHEM 522 Molecular Genetics: Genes to Genomes (3 cr.), BCHEM 590 Colloquium (2 cr.), BMS 512 Data Analysis for the Biomedical Lab Scientist (2 cr.), and at least 2 credits of 500-level elective courses selected in consultation with the student's dissertation adviser and doctoral committee.

CELLULAR AND INTEGRATIVE PHYSIOLOGY (CIP) OPTION
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The objective of the CIP Option is to provide students training that focuses on cellular and integrative physiology, which includes the functions and interactions between different tissues and cell types and different organ systems. The training afforded by this Option exposes graduates to the fundamentals needed to experimentally address scientific questions in areas such as intracellular organization, and the regulation of key biological processes including cell signaling, ion channel and transport function, gene expression, protein translation and turnover, molecular motors, and intercellular communication. In addition, the Option stresses the importance of systems biology and inter-organ signaling to understand the biological basis of health and disease. The combination of didactic courses, colloquia, seminars, and laboratory research provides students with an integrated approach for applying advanced imaging, biochemical, and molecular analyses to interrogate and manipulate basic cellular processes and macromolecules of biomedical significance.

Admission Requirements for the CIP Option
To be admitted to the CIP Option, students must successfully complete 1) the first year of the BMS Graduate Program, and 2) three research rotations, at least two with faculty in the CIP Option.

Curricular Requirements for the M.S. degree in the CIP Option
In addition to the 13 credits of required BMS Core Courses for the M.S. degree and 6 credits of thesis research, students pursuing the M.S. degree in the CIP Option must take PSIO 504 and 505 Cellular and Integrative Physiology I and II (6 cr.), BMS 581 Molecular and Translational Approaches to Human Disease (3 cr.), PSIO 501 Scientific Analysis and Presentation (2 cr.), and at least 2 credits of 500-level elective courses selected in consultation with the student's thesis adviser and thesis committee.

Curricular Requirements for the Ph.D. degree in the CIP Option
In addition to the 17 credits of required BMS Core Courses for the Ph.D. degree, students pursuing the Ph.D. degree in the CIP Option must take PSIO 504 and 505 Cellular and Integrative Physiology I and II (6 cr.), BMS 581 Molecular and Translational Approaches to Human Disease (3 cr.), PSIO 501 Scientific Analysis and Presentation (2 cr.), and at least 1 credit of a 500-level elective course selected in consultation with the student's dissertation adviser and doctoral committee.

TRANSLATIONAL THERAPEUTICS (TT) OPTION
Jong Yun, Ph.D., Option Director
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The TT Option is designed to give students a combination of didactic instruction, informal interaction, and laboratory experience that enables them to obtain a firm foundation in the principles, methods, and contributions of pharmacology, defined broadly as the science of the interaction of chemical agents with biological systems. Of primary importance, this Option focuses on identification of disease targets, development of therapeutic strategies, and refinement of drug delivery approaches. With this preparation, graduates of the TT Option will be capable of designing and executing high-quality independent research, and of assuming positions of responsibility within the therapeutic community.
This Option offers studies in the general areas of drug discovery and development, molecular pathophysiology, drug metabolism, molecular pharmacology, endocrine pharmacology, neuropharmacology, cardiovascular-renal pharmacology, pharmacogenetics, and clinical pharmacology. Primary emphasis is placed on the molecular mechanism by which drugs act in the body and by which the body transforms drugs.

**Admission Requirements for the TT Option**

To be admitted to the TT Option, students must successfully complete 1) the first year of the BMS Graduate Program, and 2) three research rotations, at least two with faculty in the TT Option.

**Curricular Requirements for the M.S. degree in the TT Option**

In addition to the 13 credits of required BMS Core Courses for the M.S. degree and 6 credits of thesis research, students pursuing the M.S. degree in the TT Option must take PHARM 520 Principles of Drug Action (2 cr.), PHARM 551 Anti-infective Therapeutics (1 cr.), PHARM 552 Integrated Systems Pharmacology (1 cr.), PHARM 553 Gastrointestinal and Immunomodulatory Therapeutics (1 cr.), PHARM 554 Anticancer Therapeutics (1 cr.), PHARM 561 Neuropharmacology (2 cr.), PHARM 562 Endocrine Pharmacology (2 cr.), PHARM 590 Colloquium (1 cr.), and at least 2 credits of 500-level elective courses selected in consultation with the student's thesis adviser and thesis committee.

**Curricular Requirements for the Ph.D. degree in the TT Option**

In addition to the 17 credits of required BMS Core Courses for the Ph.D. degree, students pursuing the Ph.D. degree in the TT Option must take PHARM 520 Principles of Drug Action (2 cr.), PHARM 551 Anti-infective Therapeutics (1 cr.), PHARM 552 Integrated Systems Pharmacology (1 cr.), PHARM 553 Gastrointestinal and Immunomodulatory Therapeutics (1 cr.), PHARM 554 Anticancer Therapeutics (1 cr.), PHARM 561 Neuropharmacology (2 cr.), PHARM 562 Endocrine Pharmacology (2 cr.), PHARM 590 Colloquium (1 cr.), and at least 1 credit of a 500-level elective course selected in consultation with the candidate's dissertation adviser and doctoral committee.

**VIROLOGY AND IMMUNOLOGY (VIRIM) OPTION**

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The objective of the VIRIM Option is to provide graduate students the opportunity to focus their graduate-level coursework and laboratory research in areas related to virology and immunology. The areas of research within virology include viral oncology, virus-cell interactions, the structure and assembly of viruses, functional role of viral gene products, the molecular biology of virus replication, and viral induced latency. The areas of research within immunology include adaptive and innate immunity, cellular and humoral immunity, antigen presentation, tumor immunology, vaccine development, and neuroimmunology. The VIRIM Option allows students to develop an integrative research approach using aspects of biochemistry, molecular and cellular biology, and genetics to approach scientific questions associated with areas of virology and immunology.

**Admission Requirements for the VIRIM Option**

To be admitted to the VIRIM Option, students must successfully complete 1) the first year of the BMS Graduate Program, and 2) three research rotations, at least two with faculty members in the VIRIM Option.

**Curricular Requirements for the M.S. degree in the VIRIM Option**

In addition to the 13 credits of required BMS Core Courses for the M.S. degree and 6 credits of thesis research, students pursuing the M.S. degree in the VIRIM Option must take MICRO 550 Medical Microbiology (2 cr.), MICRO 581 Immunology A: Basic Concepts in Innate and Adaptive Immunity (1 cr.), MICRO 582 Immunology B: Adaptive Immunity (1 cr.), BMS 562 Principles of Immunology C: Dysfunction and Manipulation of the Immune
Curricular Requirements for the Ph.D. degree in the VIRIM Option

In addition to the 17 credits of required BMS Core Courses for the Ph.D. degree, students pursuing the Ph.D. degree in the VIRIM Option must take MICRO 550 Medical Microbiology: Topics in Molecular Pathogenesis (2 cr.), MICRO 581 Immunology A: Basic Concepts in Innate and Adaptive Immunity (1 cr.), MICRO 582 Immunology B: Adaptive Immunity (1 cr.), BMS 562 Principles of Immunology C: Dysfunction and Manipulation of the Immune System (1 cr.) or BMS 566 Viral Oncogenesis (1 cr.), BMS 564 Concepts of Virology (2 cr.) or MICRO 560 Concepts in Immunology (2 cr.), BMS 567 Viral Pathogenesis (1 cr.), GENET 581 Genetics of Model Organisms A: Bacterial and Viral Pathogenesis (1 cr.), MICRO 572 Virology Literature Reports (1 cr.) or VIRIM 580 Critical Reading in Immunobiology (1 cr.), MICRO 590 Colloquium (1 cr.), and at least 2 credits of 500-level elective courses selected in consultation with the student's thesis adviser and thesis committee.

REQUIREMENTS FOR THE M.D./Ph.D. DEGREE

Students must fulfill all requirements for each degree in order to be awarded that degree. Degree requirements for the M.D. program are listed on the Penn State College of Medicine website. If students accepted into the joint degree program are unable to complete the M.D. degree, they are still eligible to receive the Ph.D. degree if all the Ph.D. degree requirements have been satisfied.

During the first two years of medical school, the student conducts at least three research rotations. After successful completion of the first two years of medical school the student enters the BMS Graduate Program and may be admitted to one of its options.

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 as the candidacy examination for the BMS Graduate Program.

In addition to the requirements for the doctoral committee for a Ph.D. student in the BMS Graduate Program, at least one member of the dissertation committee must be on the M.D./Ph.D. Steering Committee. This member may serve other roles on the doctoral committee.

M.D./Ph.D. students must complete 28 credits; 8 credits from the first two years of medical school will be double-counted towards the Ph.D., replacing the following required core courses: BMS 502 (3 cr.), BMS 503 (3 cr.), and BMS 596 (2 cr.). In addition to the curriculum of the first two years of medical school at the Penn State College of Medicine, all M.D./Ph.D. students in the BMS Graduate Program take the following core courses: BMS 506A and 506B Biological Basis of Human Health and Disease A and B (4 cr.), BMS 512 Data Analysis for the Biomedical Lab Scientist (2 cr.), BMS 590 Colloquium (4 cr.), BMS 591 Biomedical Research Ethics (1 cr.), and BMS 801 Writing Grant Proposals for Biomedical Research (1 cr.).

In addition, students must take 2 credits of Colloquium or Journal Club, which is fulfilled by taking any of the following: BCHEM 590 Colloquium, PSIO 501 Scientific Analysis and Presentation, PHARM 590 Colloquium, MICRO 590 Colloquium, MICRO 572 Virology Literature Reports, NEURO 590 Colloquium, or VIRIM 580 Critical Reading in Immunobiology, and at least 6 elective credits of 500-level elective courses selected in consultation with the student's dissertation adviser and doctoral committee.

The M.D./Ph.D. candidate prepares a written comprehensive examination in the format of a grant application and gives an oral presentation of this proposal to their doctoral committee.
A dissertation must be prepared and defended by each M.D./Ph.D. candidate. The dissertation must be accepted by the doctoral committee, the chair of the graduate program, and the Graduate School, and the student must pass a final oral examination (the dissertation defense). Students are required to have at least one first-author publication accepted or published based on their dissertation research prior to the final oral examination.

**OTHER RELEVANT INFORMATION**

The BMS Graduate Program Advisory Committee, which includes representation from the Program and each Option of the Program, advises students about academic and related matters until the student has a dissertation adviser. If desired, students formally make a decision to join an Option by the end of the Spring semester of their first year and must satisfy admission requirements of the Option.

Students must have a dissertation adviser by the end of the summer of the first year. The student and dissertation adviser then plan additional course work and develop a research plan in consultation with the doctoral committee.

**STUDENT AID**

Graduate assistantships available to students in this Program and other forms of student aid are described in the STUDENT AID section of the Graduate Bulletin. Students on graduate assistantships must adhere to the course load limits set forth in the Graduate Bulletin.

**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 to make up deficiencies or to fill gaps in previous education, but not to meet requirements for an advanced degree.
IV. Graduate Bulletin Comparison of Old and New

Biomedical Sciences (BMS)

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Degrees conferred:
Ph.D., M.D./Ph.D., M.S.
Dual-Title Ph.D. (Biomedical Sciences and Clinical and Translational Sciences)

The Program

The Biomedical Sciences (BMS) Graduate Program with its Options in Biochemistry and Molecular Genetics, Cellular and Integrative Physiology, Translational Therapeutics, and Virology and Immunology provides predoctoral students curricular training with a unique focus on human health and disease, and the opportunity to concentrate in one or more disciplinary approaches, including biochemistry, biophysics, cell biology, genetics, immunology, 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 industry, education, intellectual property development, technology licensing, journalism, entrepreneurship, and public policy.

The first-year Fall curriculum provides the student an understanding of basic cellular processes through a common curriculum that includes three parallel and integrated three-credit BMS courses arranged around the theme 'Life Requires': 1) BMS 501 Regulation of Cellular and Systemic Energy Metabolism, 2) BMS 502 Cell and Systems Biology, and 3) BMS 503 Flow of Cellular Information. The Fall curriculum also includes the one-credit Art of Scientific Communication I course that reinforces the 'Life Requires' components and aids students in the transition from textbooks to primary literature as a source of information. The first-year Spring curriculum offers an opportunity to explore one or more curricular paths that lead to entry into one of the Options and/or to utilize Integrative Physiology as a stepping-stone to an individualized curricular pathway within the BMS Graduate Program. The Spring curriculum also includes the one-credit Art of Scientific Communication II course that further develops the student's knowledge acquisition from the primary literature and assists in improvement of presentation and writing skills necessary for subsequent journal clubs, literature-based courses, and scientific discourse throughout their career. In addition, 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 a dissertation adviser and...
Curriculum in the second year is determined by the choice to participate in one of the Options, or an individualized curricular pathway designed by the interaction of the student with the dissertation adviser and doctoral committee.

Successful completion of the Program results in conferral of the Ph.D. Degree in Biomedical Sciences.

The BMS Graduate Program is an interdepartmental program that engages faculty from at least seven numerous basic science and eleven 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.

**Ph.D. ADMISSION REQUIREMENTS**

**V. Completed official Penn State Graduate School Application for Admission; Master's or Doctoral Degree**

**Admission Requirements**

Admission requirements listed here are in addition to requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.

1. Submission of online Penn State Graduate School application and payment of nonrefundable application fee
2. Graduate Record Examinations (GRE) general test scores
3. Three letters of recommendation
4. Statement of goals including a) your reasons for applying to the Biomedical Sciences BMS Graduate Program, b) previous research experiences, c) particular areas of research interests if known, and d) long-term career goals
5. Applicants must hold either (1) a baccalaureate degree from a regionally accredited U.S. institution or (2) a tertiary (postsecondary) degree. Official transcripts from all post-secondary institutions attended; Note that is deemed comparable to a four-year bachelor’s degree from a regionally accredited U.S. institution. This degree must be from an officially recognized degree-granting institution in the country in which it operates.

**M.D./Ph.D. Admission Requirements**

Prospective students interested in simultaneously pursuing a 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. Applicants must also meet the admission requirements of the Graduate School and the Ph.D. admission requirements listed above, however, GRE scores are not required. The M.D./Ph.D. Admissions Committee reviews applications and evaluates candidates for acceptance into both the M.D. and Ph.D. programs. After the review committee has accepted an applicant to the joint degree program, s/he must apply to the Graduate School for admission to the graduate program. Students must be admitted to the joint degree program prior to taking the first course they intend to count towards the graduate degree. Applicants not accepted into the joint-degree program may be referred to either the M.D. or Ph.D. program, depending on their qualifications.

Applicants to this program generally have very strong grades and MCAT scores, as well as a strong and sustained background in research. Applicants must be able to clearly articulate reasons for pursuing the joint degree. Letters of recommendation from faculty who have advised the applicant in research and who can comment on the applicant’s passion and potential for research are strongly encouraged.
Dual-Title Ph.D. Degree in Biomedical Sciences and Clinical and Translational Sciences Admission Requirements

VI. The language of instruction at Penn State is English. All international applicants must take and submit scores for the TOEFL (Test of English as a Foreign Language) or the IELTS (International English Language Testing System), with the exceptions noted below. The minimum acceptable score for the TOEFL is 550 for the paper-based test, or a total score of 80 with a 19 on the speaking section for the Internet-based test (iBT). Applicants with iBT speaking scores between 15 and 18 may be considered for provisional admission, which requires completion of specified remedial English courses ESL 114G (American Oral English for Academic Purposes) and/or ESL 116G (ESL/Composition for Academic Disciplines) and attainment of a grade of B or higher. The minimum acceptable composite score for the IELTS is 6.5.

International applicants are exempt from the TOEFL/IELTS requirement who have received a baccalaureate or a graduate degree from a college/university/insititution in any of the following: Australia, Belize, British Caribbean and British West Indies, Canada (except Quebec), England, Guyana, Republic of Ireland, Liberia, New Zealand, Northern Ireland, Scotland, the United States, and Wales.

Dual Title Ph.D. Degree in Biomedical Sciences and Clinical and Translational Sciences Admission Requirements

Potential Dual-Title trainees will dual-title students can express an interest in the Dual-Title Degree dual-title program as early as during the recruitment process for the Biomedical SciencesBMS Graduate Program. Students must apply and may be admitted to the graduate program in BMS and the Graduate School before they can apply for admission to the dual-title Ph.D. in Biomedical Sciences and in Clinical and Translational Sciences following admission to the Graduate School and Biomedical Sciences (CTS): Refer to the Admission Requirements section of the Clinical and Translational Sciences Bulletin page. Students must apply and be admitted to the dual-title program in CTS prior to taking the candidacy exam.

Degree Requirements

Lisa Shantz, Ph.D., BMS Director
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Master's Degree Requirements

The Biomedical Sciences Program awards M.S. degrees, it does not actively recruit students to earn M.S. degrees.

Requirements listed here are in addition to requirements stated in the DEGREE REQUIREMENTS section of the Graduate Bulletin.

To receive the M.S. degree in Biomedical Sciences, at least 33 credits from courses at the 400-, 500-, 600-, and 800-level are required.
1. **Required Core Courses**

   - BMS 501 Regulation of Cellular and Systemic Energy Metabolism (13 cr.)
   - BMS 502 Cell and Systems Biology
   - BMS 503 Flow of Cellular Information (6 cr.)
   - BMS 504 Art of Scientific Communication I
   - BMS 505 Art of Scientific Communication II
   - BMS 590 Colloquium (2 cr.)
   - BMS 591 Biomedical Research Ethics in the Life Sciences (1 cr.)
   - BMS 596 Individual Studies: Research Rotation (2 cr.)

2. **Required Program Courses**

   - Colloquium or Journal Club fulfilled by taking 2 credits of any of the following: BCHEM 590 Colloquium, PSIO 501 Scientific Analysis and Presentation, PHARM 590 Colloquium, MICRO 590 Colloquium, MICRO 572 Virology Literature Reports, NEURO 590 Colloquium, or VIRIM 580 Critical Reading in Immunobiology.
   - At least 11 credits of elective courses at the 500 or 800 level, selected in consultation with the student's thesis adviser and thesis committee.

3. **Thesis Research (6 cr.)**

   - BMS 600 Thesis Research (6 cr.). No more than 6 credits of BMS 600 Thesis Research may be counted toward the 36 cr. credit minimum.

4-3. **Doctoral Degree Requirements**

   - Each candidate for the Fall semester of the M.S. degree must fulfill written and spoken English communication requirements that are satisfied by preparing written and oral reports describing the laboratory rotations during the first year.

   - Students must complete original laboratory research that culminates in a thesis. Additionally, all requirements listed in the University Bulletin for the M.S. degree must be fulfilled. The thesis must be accepted by the master's committee, the chair of the graduate program, and the Graduate School.

   - To receive the Ph.D. degree in Biomedical Sciences, at least 29 credits from courses at the 400, 500, 600, and 800 level are required.

   1. **Required Core Courses**

      - BMS 501 Regulation of Cellular and Systemic Energy Metabolism (17 cr.)
      - BMS 502 Cell and Systems Biology
      - BMS 503 Flow of Cellular Information (6 cr.)
      - BMS 504 Art of Scientific Communication I
      - BMS 590 Colloquium (2 cr.)
      - BMS 591 Biomedical Research Ethics in the Life Sciences (1 cr.)
      - BMS 596 Individual Studies: Research Rotation (2 cr.)

      - In the Spring semester, students are required to take BMS 520 Integrative Physiology, BMS 590 Colloquium, and at least 11 credits of elective courses selected in consultation with the student's thesis adviser and thesis committee.

2. **Required Program Courses**

   - 2 credits of Colloquium or Journal Club fulfilled by taking any of the following: BCHEM 590 Colloquium, PSIO 501 Scientific Analysis and Presentation, PHARM 590 Colloquium, MICRO 590 Colloquium, MICRO 572 Virology Literature Reports, NEURO 590 Colloquium, or VIRIM 580 Critical Reading in Immunobiology, and at least 10 credits of elective courses selected in consultation with the BMS Graduate Program Student Advisory Committee. Each candidate for the Ph.D. degree must fulfill written and spoken English communication requirements that are satisfied by preparing written and oral reports describing the laboratory rotations during the first year.

   - At the end of the first year, admission to Ph.D. student's dissertation adviser and doctoral committee.
Each candidate for the Ph.D. degree must fulfill written and spoken English communication requirements that are satisfied by preparing written and oral reports describing the laboratory rotations during the first year.

The first-year Fall curriculum provides the student an understanding of basic cellular processes through a core curriculum that includes two integrated three-credit courses: Flow of Cellular Information and Cell and Systems Biology. These courses develop concepts related to genome structure and function, regulation of gene expression, regulation of energy supply and demand, cellular and subcellular structures, cell-to-cell signaling, and the organization and function of cells in multicellular systems. The Fall curriculum also includes the one-credit Art of Scientific Communication I course that reinforces concepts developed in the integrated courses and aids students in the transition from textbooks to primary literature as a source of information.

The first-year Spring curriculum offers an opportunity to explore one or more curricular paths that lead to entry into one of the Options or to design an individualized curricular path within the BMS Graduate Program. The Spring curriculum also includes the one-credit Art of Scientific Communication II course that further develops the student’s knowledge acquisition from the primary literature and assists improvement of presentation and writing skills necessary for subsequent journal clubs, literature-based courses, and scientific learning and discourse throughout their career.

In addition, students complete at least three research rotations during the first year that expose them to the wide range of research interests of the Penn State 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 a dissertation adviser and doctoral committee.

Curriculum in the second year is determined by the choice to participate in one of the Options, or an individualized curricular path designed by the student in consultation with the dissertation adviser and doctoral committee.

All doctoral students must pass a candidacy examination, a comprehensive examination, and a final oral examination (the dissertation defense). At the end of the first year, admission to Ph.D. candidacy is determined by performance in course work, laboratory rotations, and the BMS Graduate Program Candidacy Examination. Students join their research laboratory by the end of the summer of the first year.

Ph.D. candidates prepare a written comprehensive examination in the format of a grant application prior to the end of the fifth semester of enrollment. As part of this examination, the candidate also gives an oral presentation of this proposal to their doctoral committee.

The doctoral committee of a Ph.D. student is formed upon entry into the thesis laboratory. To earn the Ph.D. degree, doctoral students must write a dissertation that is accepted by the doctoral committee, the chair of the graduate program, and the Graduate School. Students are required to have at least one first-author publication accepted or published based on their dissertation research prior to the final oral examination. A student may petition the Chair of the BMS Graduate Program 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.

**Dual-Title Doctoral Degree Requirements**

To qualify for the dual-title degree in Biomedical Sciences and Clinical and Translational Sciences, students must satisfy the BMS Ph.D. degree requirements listed in the “Doctoral Degree Requirements” section above. In addition, students pursuing the dual-title Ph.D. in BMS and CTS must complete the degree requirements for the dual-title CTS Ph.D., listed on the CTS Bulletin.
Up to 7 credits for the Ph.D. degree in BMS that overlap with the CTS elective requirements can be counted toward the CTS dual-title.

The choice of CTS electives is subject to approval by the student's academic adviser(s) from the BMS and CTS programs. The electives should complement the student's work in BMS. A list of approved electives is maintained by the CTS program office.

The candidacy examination contains elements of both BMS and CTS. In accordance with Graduate Council policy, the candidacy committee must include at least two faculty members in the major field. In addition, an official "outside one member" must be appointed as one of the four members. The outside member may not have a budgetary connection or adjunct appointment or other conflict of interest with the department or academic unit to which the doctoral program belongs, or to the department or academic unit of the chair or dissertation advisor, and cannot serve as either chair or co-chair of the committee.

During the second year, students take BMS 581 Molecular & Translational Approaches to Human Disease, BMS 590 Colloquium, and elective courses that are selected in consultation with the student's dissertation adviser and doctoral committee.

Ph.D. candidates prepare a written comprehensive examination in the format of a grant application prior to the end of the fifth semester of enrollment. As part of this examination, the candidate also gives an oral presentation of this proposal to their doctoral committee.

It is expected that the Ph.D. candidate will have at least one paper submitted for publication in a major peer-reviewed scientific journal prior to the doctoral examination. A dissertation must be prepared and defended by each Ph.D. candidate.

Dual-Title Doctoral Degree Requirements

Biomedical Sciences graduate students accepted to the Clinical and Translational Sciences Dual-Title Program will take the candidacy exam at the end of the third semester of graduate training: 1) to allow exposure to the Clinical and Translational Sciences Curriculum in the Fall semester of the second year, which will better prepare the students for the integrated content of the dual-title candidacy exam; and 2) to allow enough time to identify and assure commitment of an appropriate dissertation mentor who embraces the dual-title program of the student. During the candidacy process, the student will also be assessed for candidacy to the dual-title program, and at least one member of the candidacy committee must come from the dual-title program. of the CTS Graduate Faculty members who hold Faculty with graduate appointments in both programs may serve in a combined role. Dual-title graduate degree students may require an additional semester to fulfill requirements for both areas of study and, therefore, the candidacy examination may be delayed one semester beyond the normal period allowable.

In accordance with Graduate Council requirements, the doctoral committee shall contain at least four members. At least one regular member of the doctoral committee must represent a field outside the candidate's major field of study in order to provide a broader range of disciplinary perspectives and expertise. This committee member is referred to as the "Outside Field Member." In cases where the candidate is also pursuing a dual-title field of study, the dual-title representative to the committee may serve as the Outside Field Member.

Additionally, in order to avoid potential conflicts of interest, the primary appointment of at least one regular member of the doctoral committee must be in an administrative unit that is outside the unit in which the dissertation advisor's primary appointment is held (i.e., the advisor's administrative home; in the case of tenure-line faculty, this is the individual's tenure home). This committee member is referred to as the "Outside Unit Member." In the case of co-advisers, the Outside Unit Member must be from outside the administrative home(s) of both co-advisers. In some cases, an individual may have a primary appointment outside the administrative home of the student's dissertation adviser and also represent a field outside the student's major field of study; in such cases, the same individual may serve as both the Outside Field Member and the Outside Unit Member. Include at least one member of the CTS Graduate Faculty.

The committee chair will be a member of the Graduate Faculty in the primary area of study or the dual-title program. Faculty members who hold appointments in both the primary area Graduate Faculty of study and the CTS program both programs may serve in a combined role.
If the chair of the doctoral committee does not serve in this combined role, the faculty member-a member of the Graduate Faculty in CTS, the member of the committee representing the CTS program must be designated appointed as co-chair of the committee. The fields of BMS and CTS representatives will be expected to assist integrated in constructing and evaluating the student's comprehensive examination questions that cover the secondary area of study.

M.D./Ph.D. Admissions Requirements

Applicants must hold either (1) a baccalaureate degree from a regionally accredited U.S. institution or (2) a tertiary (postsecondary) degree that is deemed comparable to a four-year bachelor's degree from a regionally accredited U.S. institution. This degree must be from an officially recognized degree-granting institution in the country in which it operates.

• 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 MCAT scores of 33-34. Applicants are not required to take the GREs.

• Research Experience
We are especially interested in candidates with a strong and sustained background in research. Candidates who have spent 1-2 years after graduation conducting research are strongly encouraged to apply.

• 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 exam, and the doctoral committee member representing CTS is responsible for researching coverage of information relevant to the CTS field of study.

• Goals
Applicants must be able to clearly articulate the reasons for pursuing the joint degree.

• International Students
All qualified candidates are eligible to apply regardless of citizenship. (http://www.pennstatehershey.org/web/md/admissions/overview/requirements)

OTHER RELEVANT INFORMATION

The BMS Graduate Program Student Advisory Committee, which includes representation from the Program and each Option of the Program, advises students about academic and related matters until the student has a dissertation adviser. First-year students carry out a series of rotation projects in at least three different faculty laboratories before deciding on a research laboratory. If desired, students formally make a decision to join an Option by the end of the Spring semester of their first year and must satisfy all admission requirements of the Option.

Students must have a dissertation adviser by the end of the summer of the first year. The student and dissertation adviser then plan additional coursework and develop a research plan in consultation with the doctoral committee.

STUDENT AID

Graduate assistantships available to students in this Program and other forms of student aid are described in the STUDENT AID section of the Graduate Bulletin.

COURSES

The candidate must complete a dissertation on a topic that reflects their original research and education in both BMS and CTS. To earn the dual-title Ph.D. degree, the dissertation must be accepted by the doctoral committee, the chair of the graduate program, and the Graduate School, and the student must pass a final oral examination (the dissertation defense).

OPTIONS
The Options offered within the BMS Graduate Program provide the student a curricular specialization focused on different approaches to biomedical research.

BIOCHEMISTRY AND MOLECULAR GENETICS

Graduate courses carry numbers from 500 to 699 and 800 to 899.

Biochemistry and Molecular Genetics (BMG) Option

John M. Flanagan, Ph.D., Option Director
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The objective of the BMG Option in Biochemistry and Molecular Genetics is to provide students in the Biomedical Sciences (BMS) Graduate Program the opportunity to specialize their graduate curriculum/course work and laboratory training both on the principles and application of biochemical and molecular genetic analysis. These approaches play key roles in identifying and characterizing cellular processes and elucidating the structure and function of key macromolecules including DNA, RNA, protein, lipid proteins, lipids, and carbohydrates. The Option also stresses the biological intersections of these classes of macromolecules. The combination of didactic courses, colloquia, seminars, and laboratory research provides students with an integrated approach for applying biochemical and molecular genetic analysis to interrogate and manipulate basic cellular processes and macromolecules of biomedical significance. The training afforded by this Option exposes graduates to the fundamentals needed to experimentally address scientific questions in areas such as epigenetic control of gene expression, structure/function, biomolecular engineering, and systems analysis using genetic and biochemical approaches.

ADMISSION REQUIREMENTS

Admission Requirements for the BMG Option

To be admitted to the Option in Biochemistry and Molecular Genetics, students must successfully complete 1) the first year of the BMS Graduate Program and 2) three research rotations, at least two with faculty in the BMG Option.

Curricular Requirements for the M.S. degree in the BMG Option

In addition to the 13 credits of required BMS Core Courses for the M.S. degree and 6 credits of thesis research, students pursuing the M.S. degree in the BMG Option must take BCHEM 521 Structure, Function, and Regulation of Biological Molecules (3 cr.), BCHEM 522 Molecular Genetics: Genes to Genomes (3 cr.), BCHEM 590 Colloquium (2 cr.), BMS 512 Data Analysis for the Biomedical Lab Scientist (2 cr.), and at least 3 credits of 500-level elective courses selected in consultation with the student’s thesis adviser and thesis committee.

Curricular Requirements for the Ph.D. candidate degree in the BMG Option

In addition to the 17 credits of required BMS Core Courses for the Ph.D. degree, students pursuing the Ph.D. degree in the BMG Option must take
BCHEM 521 Structure, Function, and Regulation of Biological Molecules (3 cr.), BCHEM 522 Molecular Genetics: Genes to Genomes (3 cr.), BCHEM 590 Colloquium (2 cr.), BMS 512 Data Analysis for the Biomedical Lab Scientist (2 cr.), and at least 2 credits of 500-level elective courses selected in consultation with the student's dissertation adviser and doctoral committee.

CELLULAR AND INTEGRATIVE PHYSIOLOGY (CIP) OPTION

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The objective of the CIP Option is to provide students training that focuses on cellular and integrative physiology, which includes the functions and interactions between different tissues and cell types and different organ systems. The training afforded by this Option exposes graduates to the fundamentals needed to experimentally address scientific questions in areas such as intracellular organization, and the regulation of key biological processes including cell signaling, ion channel and transport function, gene expression, protein translation and turnover, molecular motors, and intercellular communication. In addition, the Option stresses the importance of systems biology and inter-organ signaling to understand the biological basis of health and disease. The combination of didactic courses, colloquia, seminars, and laboratory research provides students with an integrated approach for applying advanced imaging, biochemical, and molecular analyses to interrogate and manipulate basic cellular processes and macromolecules of biomedical significance.

Admission Requirements for the CIP Option

To be admitted to the CIP Option, students must successfully complete 1) the first year of the BMS Graduate Program, and 2) three research rotations, at least two with faculty in the Biochemistry and Molecular Genetics CIP Option, and 3) the BMS Graduate Program Candidacy examination.

Master's Degree Requirements

The Biochemistry and Molecular Genetics Option does not actively recruit students to earn an M.S. degree. To receive an M.S. degree in The Biochemistry and Molecular Genetics Option at least 36 credits from courses at the 500- or 600-level are required.

Curricular Requirements for the M.S. degree in the CIP Option

In addition to the 13 credits of required BMS Core Courses for the M.S. degree and 6 credits of thesis research, students pursuing the M.S. degree in the CIP Option must take PSIO 504 and 505 Cellular and Integrative Physiology I and II (6 cr.), BMS 581 Molecular and Translational Approaches to Human Disease (3 cr.), PSIQ

Required Core Courses: BMS 501 Regulation of Cellular and Systemic Energy Metabolism, BMS 502 Cell and Systems Biology, BMS 503 Flow of Cellular Information, BMS 504 Art of Scientific Communication I, BMS 506 Art of Scientific Communication II, BMS 591 Ethics in the Life Sciences, BMS 596 Individual Studies: Research Rotation, and BMS 600 Thesis Research (no more than 6 credits of BMS 600 Thesis Research may be counted toward the 36 credit limit), Scientific Analysis and Presentation (2 cr.), and at least 2 credits of 500-level

Required Option Courses: BCHEM 521 Structure, Function, and Regulation of Biological Molecules, BCHEM 522 Molecular Genetics: Genes to Genomes, BCHEM 590 Colloquium, BCHEM 596 Individual Studies: Research Rotation, and at least 7 credits of elective courses selected in consultation with the student's thesis adviser and thesis committee.

Students must complete original laboratory research that culminates in a thesis. Additionally, all requirements listed in the University Bulletin for the M.S. degree must be fulfilled.

Doctoral Degree Requirements

During the Fall semester of the first year of study, Ph.D. candidates take BMS 501 Regulation of Cellular and Systemic Energy Metabolism, BMS 502 Cell and Systems Biology, BMS 503 Flow of Cellular Information, BMS 504 Art of Scientific Communication I, and BMS 596 Individual Studies:
Research Rotation. In the Spring semester, students considering joining the Option in Biochemistry and Molecular Genetics take BCHEM 521 Structure, Function, and Regulation of Biological Molecules, BCHEM 522 Molecular Genetics: Genes

Curricular Requirements for the Ph.D. degree in the CIP Option

In addition to Genomes, BMS 505 Art of Scientific Communication II, and BCHEM 596 Individual Studies: Research Rotation, each candidate must fulfill written and spoken English communication requirements that are satisfied by preparing written and oral reports describing laboratory rotations done during the first year.

At the end of the first year, admission to the Ph.D. candidacy and degree in the CIP Option in Biochemistry and Molecular Genetics is determined by performance in course work, laboratory rotations, and the BMS Graduate Program Candidacy examination. Students join their research laboratory by the end of the summer of the first year.

During the second year, students take BCHEM 590 Colloquium; must take PSIO 504 and 505 Cellular and Integrative Physiology I and II (6 cr.), BMS 581 Molecular and Translational Approaches to Human Disease (3 cr.), PSIO 501 Scientific Analysis and Presentation (2 cr.), and at least 1 credit of a 500-level didactic elective course selected in consultation with the student’s dissertation adviser and doctoral committee.

TRANSLATIONAL THERAPEUTICS (TT) OPTION

Jong Yun, Ph.D., Option Director

The Pennsylvania State University College of Medicine
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Ph.D. candidates prepare a written comprehensive examination in the format of a grant application prior to the end of the fifth semester of enrollment. As part of this examination, the candidate also gives an oral presentation of this proposal to their doctoral committee.

It is expected that the Ph.D. candidate will have at least one paper submitted for publication in a major peer-reviewed scientific journal prior to the doctoral examination. A dissertation must be prepared and defended by each Ph.D. candidate.

Translational Therapeutics kyy1@psu.edu

The TT Option

Jong Yun, Ph.D., Option Director

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The Option in Translational Therapeutics of the Biomedical Sciences (BMS) Graduate Program is designed to give qualified students a combination of didactic instruction, informal interaction, and laboratory experience that enables them to obtain a firm foundation in the principles, methods, and contributions of pharmacology, defined broadly as the science of the interaction of chemical agents with biological systems. Of primary importance, this Option focuses on identification of disease targets, development of therapeutic strategies, and refinement of drug delivery approaches. With this preparation, graduates of the Translational Therapeutics TT Option will be capable of designing and executing high-quality independent research, and of assuming positions of responsibility within the therapeutic community.

This Option offers studies in the general areas of drug discovery and development, molecular pathophysiology, drug metabolism, molecular pharmacology, endocrine pharmacology, neuropharmacology, cardiovascular-renal pharmacology, pharmacogenetics, and clinical pharmacology.
Primary emphasis is placed on the molecular mechanism by which drugs act in the body and by which the body transforms drugs.

**ADMISSION REQUIREMENTS**

**Admission Requirements for the TT Option**

To be admitted to the Option in Translational Therapeutics, Ph.D. candidates TT Option, students must successfully complete 1) the first year of the BMS Graduate Program, and 2) three research rotations, at least two with faculty in the Translational Therapeutics Option, and 3) the Candidacy exam.

**Master's Degree Requirements**

The Translational Therapeutics TT Option does not actively recruit students to earn an M.S. degree. In addition to the 13 credits from courses at the 500- or 600-level are of required.

1. Required BMS Core Courses: BMS 501 Regulation of Cellular and Systemic Energy Metabolism, BMS 502 Cell and Systems Biology, BMS 503 Flow of Cellular Information, BMS 504 Art of Scientific Communication I, BMS 505 Art of Scientific Communication II, BMS 506 Ethics in the Life Sciences, BMS 506 Individual Studies: Research Rotation, and BMS 600 Thesis Research (no more than 6 credits of BMS 600 Thesis Research may be counted toward the 36 credit minimum).

2. Required thesis research, students pursuing the M.S. degree in the TT Option Courses: must take PHARM 520 Principles of Drug Action, (2 cr.), PHARM 551 Anti-infective Therapeutics, (1 cr.), PHARM 552 Integrated Systems Pharmacology, (1 cr.), PHARM 553 Gastrointestinal and Immunomodulatory Therapeutics, (1 cr.), PHARM 554 Anticancer Therapeutics, (1 cr.), PHARM 561 Neuropharmacology, (2 cr.), PHARM 562 Endocrine Pharmacology, (2 cr.), PHARM 590 Colloquium (1 cr.), and at least 2 credits of 500-level elective courses selected in consultation with the student’s thesis adviser and thesis committee.

Students must complete original laboratory research that culminates in required BMS Core Courses for the Ph.D. degree in the TT Option.

In addition to the 17 credits of required BMS Core Courses for the Ph.D. degree, students pursuing the Ph.D. degree in a thesis. Additionally, all requirements listed in the University Bulletin for the M.S. degree in the TT Option must be fulfilled.

**Doctoral Degree Requirements**

During the Fall semester of the first year of study, Ph.D. candidates take BMS 501 Regulation of Cellular and Systemic Energy Metabolism, BMS 502 Cell and Systems Biology, BMS 503 Flow of Cellular Information, BMS 504 Art of Scientific Communication I, and BMS 506 Individual Studies: Research Rotation. In the Spring semester, students considering joining the Option in Translational Therapeutics take PHARM 520 Principles of Drug Action, BMS 505 Art of Scientific Communication II, PHARM 506 Individual Studies: Research Rotation, and elective courses selected in consultation with the BMS Graduate Program Student Advisory Committee. Each candidate for the Ph.D. degree must fulfill written and spoken English communication requirements that are satisfied by preparing written and oral reports describing laboratory rotations done during the first year.

At the end of the first year, admission to Ph.D. candidacy and the Option in Translational Therapeutics is determined by performance in course work, laboratory rotations, and the BMS Graduate Program Candidacy examination. Candidates join their research laboratory by the end of the summer of the first year.

During the second year, students take PHARM 551 Anti-infective Therapeutics, (1 cr.), PHARM 552 Integrated Systems Pharmacology, (1 cr.), PHARM 553 Gastrointestinal and Immunomodulatory Therapeutics, (1 cr.), PHARM 554 Anticancer Therapeutics, (1 cr.), PHARM 561
Ph.D. candidates prepare a written comprehensive examination in the format of a grant application prior to the end of the fifth semester of enrollment. As part of this examination, the candidate also gives an oral presentation of this proposal to their doctoral committee.

It is expected that the Ph.D. candidate will have at least one paper submitted for publication in a major peer-reviewed scientific journal prior to the doctoral examination. A dissertation must be prepared and defended by each Ph.D. candidate.

Virology and Immunology Option

Todd D. Schell, Ph.D., Director

The Pennsylvania State University College of Medicine

The objective of the VIRIM Option in Virology and Immunology is to provide graduate students in the Biomedical Sciences (BMS) Graduate Program the opportunity to focus their graduate-level coursework and laboratory research in areas related to virology and immunology. The areas of research within virology include viral oncology, virus-cell interactions, the structure and assembly of viruses, functional role of viral gene products, the molecular biology of virus replication, and viral induced latency. The areas of research within immunology include adaptive and innate immunity, cellular and humoral immunity, antigen presentation, tumor immunology, vaccine development, and neuroimmunology. The VIRIM Option in Virology and Immunology allows students to develop an integrative research approach using aspects of biochemistry, molecular and cellular biology, and genetics to approach scientific questions associated with areas of virology and immunology.

This Option is offered only through the BMS Graduate Program at the Penn State College of Medicine in Hershey.

ADMISSION REQUIREMENTS

Admission Requirements for the VIRIM Option

To be admitted to the VIRIM Option in Virology and Immunology, Ph.D. candidates must successfully complete: (1) the first year of the BMS Graduate Program, (2) three research rotations, at least two with faculty members in the Virology and Immunology VIRIM Option, and (3) the Candidacy examination.

Master's Degree

Curricular Requirements

In addition to earn an M.S. degree in The Virology and Immunology Option at least 41 credits from courses at the 600- or 800-level are required.

1. Required BMS Core Courses: BMS 501 Regulation of Cellular and Systemic Energy Metabolism, BMS 502 Cell and Systems Biology, BMS 503 Flow of Cellular Information, BMS 504 Art of Scientific Communication I, BMS 505 Art of Scientific Communication II, BMS 506 Ethics in the Life Sciences, BMS 508 Individual Studies: Research Rotation, and BMS 600 Thesis Research (no more than 6 credits of BMS 600 Thesis Research may be counted toward thesis research; students pursuing the 41 credit minimum).

2. Required M.S. degree in the VIRIM Option Courses: MICRO 550 Medical Microbiology: Topics in Molecular Pathogenesis, MICRO 553
Science of Virology, MICRO 560 Concepts in Immunology, MICRO 572 Literature Reports, (2 cr.), MICRO 581 Immunology A: Basic Concepts in Innate and Adaptive Immunity, (1 cr.), MICRO 582 Immunology B: Adaptive Immunity, MICRO 583 (1 cr.), BMS 562 Principles of Immunology C: Dysfunction and Manipulation of the Immune System (1 cr.) or BMS 566 Viral Vectors, MICRO 560 Colloquium, MICRO 566 Individual Studies: Research Rotation, MICRO 602 Supervised Experience in College Teaching, Oncogenesis (1 cr.), BMS 564 Concepts of Virology (2 cr.) or MICRO 560 Concepts in Immunology (2 cr.), BMS 567 Viral Pathogenesis (1 cr.), GENET 581 Genetics of Model Organisms A: Bacterial and Viral Pathogenesis, and IBIOS (1 cr.), MICRO 572 Virology Literature Reports (1 cr.) or VIRIM 580 Critical Readings in Immunology, Reading in Immunobiology (1 cr.), MICRO 590 Colloquium (1 cr.), and at least 2 credits of 500-level elective courses selected in consultation with the student’s thesis adviser and thesis committee.

Students must complete original laboratory research that culminates in a thesis. Additionally, all requirements listed in the University Bulletin for the M.S. degree must be fulfilled.

Doctoral Degree Requirements

During Curricular Requirements for the Ph.D. degree in the VIRIM Option

In addition to the fall semester, 17 credits of the first year of study, Ph.D. candidates take required BMS 501 (Regulation of Cellular and Systemic Energy Metabolism), BMS 502 (Cell and Systems Biology), BMS 503 (Flow of Cellular Information), BMS 504 (Art of Scientific Communication I), and BMS 506 (Individual Studies: Research Rotation).

Core Courses for the Spring semester Ph.D. degree, students who are considering joining the Ph.D. degree in the VIRIM Option in Virology and Immunology should take MICRO 550 (Medical Microbiology), Topics in Molecular Pathogenesis, (2 cr.), MICRO 581 (Immunology A: Basic Concepts in Innate and Adaptive Immunity), MICRO 582 (Immunology B: Adaptive Immunity), MICRO 560 (Concepts in Immunology), MICRO 562 (Supervised Experience in College Teaching) and BMS 568 (Art of Scientific Communication II). Each candidate for the Ph.D. degree must fulfill written and spoken English communication requirements that are satisfied by preparing written and oral reports describing the laboratory rotations that were performed during the first year (1 cr.), BMS 562 Principles of Immunology C: Dysfunction and Manipulation of the program.

At the end of the first year, admission to Ph.D. candidacy and the Option in Virology and Immunology is determined by successful performance in course work, laboratory rotations, and the BMS Graduate Program Candidacy examination. Students join their research laboratory by the end of the summer of the first year.

During the second year, students take MICRO 553 (Science of Virology), Immune System (1 cr.) or BMS 566 Viral Oncogenesis (1 cr.), BMS 564 Concepts of Virology (2 cr.) or MICRO 560 (Concepts in Immunology), MICRO 602 (Supervised Experience in College Teaching), MICRO 572 Literature Reports, MICRO 583 (Viral Vectors), MICRO 560 (Colloquium), GENET 581 (Genetics of Model Organisms A: Bacterial and Viral Pathogenesis (1 cr.), MICRO 552 Virology Literature Reports (1 cr.) or VIRIM 580 Critical Reading in Immunology.

Ph.D. candidates prepare a written comprehensive examination in the format of a grant application usually prior to the end of the sixth semester of enrollment. As a part of this examination, the candidate also participates in an oral defense of this proposal, Immunobiology (1 cr.), MICRO 590 Colloquium (1 cr.), and at least 1 credit of a 500-level elective course selected in consultation with the candidate’s dissertation adviser and doctoral committee.

It is expected that the Ph.D. candidate will have at least one paper submitted for publication in a major peer-reviewed scientific journal prior to the doctoral examination. A dissertation must be prepared and defended for the successful completion of the Ph.D. degree.

Requirements for the M.D./Ph.D. Degree Requirements
Prospective 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. The College of Medicine M.D./Ph.D. Admissions Committee reviews applications and evaluates candidates for acceptance into both the M.D. and Ph.D. Students must fulfill all requirements for each degree in order to be awarded that degree. Degree requirements for the M.D. program are listed on the Penn State College of Medicine website. If students accepted into the joint degree program are unable to complete the M.D. degree, they are still eligible to receive the Ph.D. degree if all the Ph.D. degree requirements have been satisfied.

M.D. program. Candidates not accepted into the joint degree program can be referred to either the M.D. or Ph.D. Students must complete 28 credits; 8 credits from the first two years of medical school will be double-counted towards the Ph.D., replacing the following required core courses: BMS 502 (3 cr.), BMS 503 (3 cr.), and BMS 596 (2 cr.), or Ph.D. program, depending on their qualifications.

During the first two years of medical school, the student conducts at least three research rotations. After successful completion of the first two years of medical school the candidate enters the BMS Graduate Program and may be admitted to one of its three options, each of which may have different credit requirements.

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 as the Candidacy Examination for the BMS program and its Options. During this time, M.D./Ph.D. students must complete 28 credits; 8 credits from the first two years of medical school will be double-counted towards the Ph.D., replacing the following required core courses: BMS 502 (3 cr.), BMS 503 (3 cr.), and BMS 596 (2 cr.).

M.D./Ph.D. students must complete 28 credits; 8 credits from the first two years of medical school will be double-counted towards the Ph.D., replacing the following required core courses: BMS 502 (3 cr.), BMS 503 (3 cr.), and BMS 596 (2 cr.). In addition to the curriculum of the first two years of medical school at the Penn State College of Medicine, all M.D./Ph.D. students in the BMS program are required to take BMS 581 Molecular & Translational Approaches to Human Disease. Additional required courses are BMS 506A and 506B Biological Basis of Human Health and Disease A and B (4 cr.), BMS 512 Data Analysis for the Biomedical Lab Scientist (2 cr.), BMS 590 Colloquium (4 cr.), BMS 591 Biomedical Research Ethics (1 cr.), and BMS 801 Writing Grant Proposals for Biomedical Research (1 cr.).

In addition, students must take 2 credits of Colloquium or Journal Club, which is fulfilled by taking any of the following: BCHM 590 Colloquium, PSIO 501 Scientific Analysis and Presentation, PHARM 590 Colloquium, MICRO 590 Colloquium, MICRO 572 Virology Literature Reports, NEURO 590 Colloquium, or VIRIM 580 Critical Reading in Immunobiology, and at least 6 elective credits of 500-level elective courses selected in consultation with the student's dissertation adviser and doctoral committee.

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

It is expected that the M.D./Ph.D. candidate will have at least one paper submitted for publication in a major peer-reviewed scientific journal prior to the final doctoral examination.
A dissertation must be prepared and defended by each M.D./Ph.D. candidate.

**Biochemistry and Molecular Genetics Option Requirements**

The dissertation must be accepted by the doctoral committee, the chair of the M.D./Ph.D. student in the Biochemistry and Molecular Genetics Option, is formed upon entry into the thesis laboratory. The committee must include a minimum of four faculty members, i.e., the chair and at least three additional members, all of whom must be members of the Graduate program, and the Graduate Faculty. The committee must include at least two members of the major program graduate faculty and at least two members of the faculty of the Biochemistry and Molecular Genetics Option. If the dissertation adviser is not a member of the Option, a co-adviser who is a member of the Option must be appointed to the committee. At least one member of the doctoral committee must represent a field outside the candidate's major field of study in order to provide a broader range of disciplinary perspectives and expertise. This committee member is referred to as the 'Outside Field Member.'

M.D./Ph.D. students in the BMG Option School, and the student must pass a final oral examination (the dissertation defense). Students are required to take BCHEM 521 Structure, Function, and Regulation of Biological Molecules and BCHEM 522 Molecular Genetics: Genes to Genomes. Additional courses are selected in consultation with the student's dissertation advisor and doctoral committee.

The M.D./Ph.D. candidate prepares a written comprehensive examination in the format of a grant application and gives an oral presentation of this proposal to have at least one first-author publication accepted or published based on their doctoral committee.

It is expected that the MD/PhD candidate will have at least one paper submitted for publication in a major peer-reviewed scientific journal dissertation research prior to the final doctoral examination. A dissertation must be prepared and defended by each MD/PhD candidate oral examination.

**OTHER RELEVANT INFORMATION**

The BMS Graduate Program Advisory Committee, which includes representation from the Program and each Option of the Program, advises students about academic and related matters until the student has a dissertation adviser. If desired, students formally make a decision to join an Option by the end of the Spring semester of their first year and must satisfy admission requirements of the Option.

Students must have a dissertation adviser by the end of the summer of the first year. The student and dissertation adviser then plan additional coursework and develop a research plan in consultation with the doctoral committee.

**STUDENT AID**

Graduate assistantships available to students in this Program and other forms of student aid are described in the STUDENT AID section of the Graduate Bulletin. Students on graduate assistantships must adhere to the course load limits set forth in the Graduate Bulletin.

**COURSES**

Graduate courses carry numbers from 500 to 699 and 800 to 899. Translational Therapeutic Option Requirements

The doctoral committee of a M.D./Ph.D. student in the Translational Therapeutic Option is formed upon entry into the thesis laboratory. The committee must include a minimum of four faculty members, i.e., the chair and at least three additional members, all of whom must be members of the Graduate Faculty. The committee must include at least one member of the major program graduate faculty and at least two members of the faculty of the Translational Therapeutics Option. If the dissertation adviser is not a member of this Option, a co-adviser who is a member of the Option must be appointed to the committee. At least one member of the doctoral committee must represent a field outside the candidate's major field of study in order to provide a broader range of disciplinary perspectives and expertise. This committee member is referred to as the 'Outside Field Member.'

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 to make up deficiencies or to fill gaps in previous education, but not to meet requirements for an advanced degree.
M.D./Ph.D students in the Translational Therapeutics Option are required to take PHARM 520 Principles of Drug Action. Additionally, the candidate takes elective courses selected in consultation with the candidate’s dissertation adviser and doctoral committee.

The candidate prepares a written comprehensive examination in the format of a grant application and gives an oral presentation of this proposal to the doctoral committee.

It is expected that the M.D./Ph.D. candidate will have at least one paper submitted for publication in a major peer-reviewed scientific journal prior to the final doctoral examination. A dissertation must be prepared and defended by each M.D./Ph.D. candidate.

Virology and Immunology Option Requirements

The doctoral committee of a M.D./Ph.D. student in the Virology and Immunology Option is formed upon entry into the thesis laboratory. The committee must include a minimum of four faculty members, i.e., the chair and at least three additional members, all of whom must be members of the Graduate Faculty. The committee must include at least two members of the major program graduate faculty. If the dissertation-adviser is not a member of this Option, a co-adviser who is a member of the Option must be appointed to the committee. At least one member of the doctoral committee must represent a field outside the candidate’s major field of study in order to provide a broader range of disciplinary perspectives and expertise. This committee member is referred to as the “Outside Field Member.”

M.D./Ph.D. students in the Virology and Immunology Option are required to take MICRO 553 (Science of Virology), MICRO 560 (Concepts in Immunology), IBIOS 580 (Critical Reading in Immunology), MICRO 572 (Literature Reports), MICRO 580 (Colloquium), MICRO 583 (Viral Vectors), GENET 581 (Genetics of Model Organisms A: Bacterial and Viral Pathogenesis), and MICRO 602 (Supervised Experience in College Teaching).

Comprehensive Examination

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

Final Doctoral Examination

It is expected that the M.D./Ph.D. candidate will have at least one paper submitted for publication in a major peer-reviewed scientific journal prior to the final doctoral examination. A dissertation must be prepared and defended by each M.D./Ph.D. candidate.
VII.V. The Graduate Faculty

Shantu Amin, Ph.D. (STEVENS INSTITUTE OF TECHNOLOGY), Professor of Pharmacology
Alaa S. Awad, M.D. (CAIRO UNIVERSITY), Associate Professor of Nephrology, and Cellular and Molecular Physiology
Alistair J. Barnstable, Ph.D. (OPEN UNIVERSITY), Associate Professor of Ophthalmology
Colin J. Barnstable, D.Phil. (UNIVERSITY OF OXFORD), Professor of Neural and Behavioral Sciences, and Psychiatry
Alfredo Bellon, M.D., Ph.D. (NATIONAL UNIVERSITY OF MEXICO), Assistant Professor of Psychiatry, and Pharmacology
Arthur S. Berg, Ph.D. (UNIVERSITY OF CALIFORNIA SAN DIEGO), Associate Professor of Public Health Sciences, and Statistics
Maria C. Bewley, Ph.D. (UNIVERSITY OF LEEDS), Associate Professor of Biochemistry and Molecular Biology
Milena Bogunovic, M.D., Ph.D. (ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI), Assistant Professor of Microbiology and Immunology
James Broach, Ph.D. (UNIVERSITY OF CALIFORNIA BERKELEY), Professor of Biochemistry and Molecular Biology
Sarah K. Bronson, Ph.D. (WASHINGTON UNIVERSITY IN ST. LOUIS), Associate Professor of Cellular and Molecular Physiology
Kirsteen N. Browning, Ph.D. (UNIVERSITY OF ABERDEEN), Associate Professor of Neural and Behavioral Science
Nicholas Buchkovich, Ph.D. (UNIVERSITY OF PENNSYLVANIA), Assistant Professor of Microbiology and Immunology
Laura Carrel, Ph.D. (STANFORD UNIVERSITY), Associate Professor of Biochemistry and Molecular Biology
Keith C. Cheng, M.D., Ph.D. (NEW YORK UNIVERSITY), Professor of Pathology, Biochemistry and Molecular Biology, and Pharmacology
Hui-Ling Chiang, Ph.D. (HARVARD UNIVERSITY), Professor of Cellular and Molecular Physiology
Neil D. Christensen, Ph.D. (UNIVERSITY OF AUCKLAND), Professor of Pathology, and Microbiology and Immunology
Zissis C. Chroneos, Ph.D. (UNIVERSITY OF SOUTH CAROLINA-COLUMBIA), Associate Professor of Pediatrics, and Microbiology and Immunology
Gary A. Clawson, M.D., Ph.D. (MICHIGAN STATE UNIVERSITY), Professor of Pathology, and Biochemistry and Molecular Biology
James R. Connor, Ph.D. (UNIVERSITY OF CALIFORNIA BERKELEY), Distinguished Professor of Neurosurgery, Neural and Behavioral Sciences, and Pediatrics
Rebecca C. Craven, Ph.D. (UNIVERSITY OF TENNESSEE AT KNOXVILLE), Professor of Microbiology and Immunology
Traci Czyzyk, Ph.D. (PENNSTATE UNIVERSITY), Assistant Professor of Anesthesiology and Perioperative Medicine, and Neural and Behavioral Sciences
Arunangshu Das, Ph.D. (JADAVPUR UNIVERSITY), Assistant Professor of Biochemistry and Molecular Biology
David DeGraff, Ph.D. (UNIVERSITY OF DELAWARE), Assistant Professor of Pathology
Michael D. Dennis, Ph.D. (UNIVERSITY OF TEXAS AT AUSTIN), Assistant Professor of Cellular and Molecular Physiology
Dhimant Desai, Ph.D. (MUMBAI UNIVERSITY), Associate Professor of Pharmacology
Sinisa Dovat, M.D., Ph.D. (UNIVERSITY OF NOVI SAD), Associate Professor of Pediatrics, and Pharmacology
Kristin A. Eckert, Ph.D. (UNIVERSITY OF WISCONSIN-MADISON), Professor of Pathology, and Biochemistry and Molecular Biology
Karam El-Bayoumy, Ph.D. (NEW YORK UNIVERSITY), Distinguished Professor of Biochemistry and Molecular Biology
John Ellis, Ph.D. (UNIVERSITY OF ROCHESTER), Professor of Psychiatry, and Pharmacology
John M. Flanagan, Ph.D. (UNIVERSITY OF TENNESSEE AT KNOXVILLE), Professor of Biochemistry and Molecular Biology
Joanna Floros, Ph.D. (TEMPLE UNIVERSITY), Evan Pugh Professor of Pediatrics, Cellular and Molecular Physiology, and Obstetrics and Gynecology
Zhonghua Gao, Ph.D. (CORNELL UNIVERSITY), Assistant Professor of Biochemistry and Molecular Biology
David R. Gater, Jr., Ph.D. (UNIVERSITY OF ARIZONA), Professor of Physical Medicine and Rehabilitation
Donald L. Gill, Ph.D. (UNIVERSITY OF LONDON), Professor of Cellular and Molecular Physiology
Channe D. Gowda, Ph.D. (MYSORE UNIVERSITY), Professor of Biochemistry and Molecular Biology
Sergei A. Grigoryev, Ph.D. (LOMONOSOV MOSCOW STATE UNIVERSITY), Professor of Biochemistry and Molecular Biology
Patricia S. Grigson, Ph.D. (RUTGERS, STATE UNIVERSITY OF NEW JERSEY), Professor of Neural and Behavioral Sciences
Edward Gunther, Ph.D. (YALE UNIVERSITY), Professor of Medicine
Susan Hafenstein, Ph.D. (UNIVERSITY OF ARIZONA), Associate Professor of Medicine, and Microbiology and Immunology
Andras Hajnal, M.D., Ph.D. (UNIVERSITY OF PECS MEDICAL SCHOOL), Professor of Neural and Behavioral Sciences, and Surgery
Philippe A. Haouzi, M.D., Ph.D. (UNIVERSITE HENRI POINCARÉ), Professor of Medicine
Ping Nian He, Ph.D. (UNIVERSITY OF CALIFORNIA DAVIS), Professor of Cellular and Molecular Physiology
Nadine Hempel, Ph.D. (UNIVERSITY OF QUEENSLAND), Associate Professor of Pharmacology
Raymond J. Hohl, M.D., Ph.D. (RUSH UNIVERSITY), Professor of Medicine, and Pharmacology
Sheldon L. Holder, M.D., Ph.D. (LOMA LINDA UNIVERSITY), Associate Professor of Medicine
Gregory M. Holmes, Ph.D. (UNIVERSITY OF CONNECTICUT), Associate Professor of Neural and Behavioral Sciences
Judie Howrylak, M.D., Ph.D. (Carnegie Mellon University/University of Pittsburgh), Assistant Professor of Medicine
Jianming Hu, M.D., Ph.D. (Pennsylvania State University), Professor of Microbiology and Immunology
Kebin Hu, Ph.D. (Nanjing University), Associate Professor of Medicine, and Nephrology
Xuemei Huang, M.D., Ph.D. (Beijing Medical University), Associate Professor of Neurology, and Pharmacology
Fumiaki Imamura, Ph.D. (Kyoto University), Assistant Professor of Pharmacology
Rosalyn B. Irby, Ph.D., (University of South Florida), Associate Professor of Medicine
Faoud T. Ishmael, M.D., Ph.D. (Pennsylvania State University), Assistant Professor of Medicine, and Biochemistry and Molecular Biology
Kelly J. Karpa, Ph.D. (Pennsylvania State University), Assistant Professor of Pharmacology
Michael Katzman, Ph.D., M.D. (Columbia University), Professor of Medicine, and Microbiology and Immunology
Marc P. Kaufman, Ph.D. (University of Miami), Professor of Medicine
Ralph L. Keil, Ph.D. (Cornell University), Associate Professor of Biochemistry and Molecular Biology
Shannon L. Kelleher, Ph.D. (University of California Davis), Associate Professor of Cellular and Molecular Physiology, Pharmacology, Surgery, and Nutritional Sciences
Yongsoo Kim, Ph.D. (Northwestern University), Assistant Professor of Neural and Behavioral Sciences
Scott R. Kimball, Ph.D. (University of Vermont), Professor of Cellular and Molecular Physiology
Walter Koltun, M.D. (Harvard University), Professor of Surgery
Charles H. Lang, Ph.D. (Drexel University), Distinguished Professor of Cellular and Molecular Physiology, and Surgery
Edward Lankford, M.D., Ph.D. (Johns Hopkins University), Associate Professor of Medicine
Sang Lee, Ph.D. (Kyungpook National University), Assistant Professor of Neurosurgery
Richard S. Legro, M.D. (Icahn School of Medicine at Mount Sinai), Professor of Obstetrics and Gynecology
Robert Levenson, Ph.D. (Suny at Stony Brook), Distinguished Professor of Pharmacology, and Neural and Behavioral Sciences
Gregory S. Lewis, Ph.D. (Pennsylvania State University), Assistant Professor of Orthopaedics and Rehabilitation
Jianhua Li, Ph.D. (Norman Bethune University of Medical Sci), Professor of Medicine
Wei Li, Ph.D., (Albert Einstein College of Yeshiva University), Assistant Professor of Pediatrics
Nancy L. Lill, Ph.D. (Pennsylvania State University), Assistant Professor of Pharmacology
Dajiang Liu, Ph.D. (Rice University), Assistant Professor of Public Health Sciences
Thomas A. Lloyd, Ph.D. (Harvard University), Professor of Public Health Sciences, and Pharmacology
Aron E. Lukacher, Ph.D. (Washington University), Professor of Microbiology and Immunology
A. B. Madhankumar, Ph.D. (University of Madras), Assistant Professor of Neurosurgery
Richard B. Mailman, Ph.D. (University of North Carolina at Chapel Hill), Professor and Distinguished Senior Scholar in Pharmacology, and Neurology
Andrea Manni, M.D. (University of Florence), Professor of Medicine
Gail L. Matters, Ph.D. (University of North Carolina at Chapel Hill), Associate Professor of Biochemistry and Molecular Biology
Janette M. McAllister, Ph.D. (University of California San Diego), Professor of Pathology, and Obstetrics and Gynecology
Patricia J. McLaughlin, D.Ed. (Pennsylvania State University), Professor of Neural and Behavioral Sciences
Craig Meyers, Ph.D. (University of California Los Angeles), Distinguished Professor of Microbiology and Immunology
Barbara A. Miller, M.D. (Pennsylvania State University), Professor of Pediatrics, and Biochemistry and Molecular Biology
George Lucian Moldovan, Ph.D. (Ludwig Maximilians Universitat Munchen), Assistant Professor of Biochemistry and Molecular Biology
Daniel Morgan, Ph.D. (Rutgers, State University of New Jersey), Assistant Professor of Anesthesiology and Perioperative Medicine, and Neural and Behavioral Sciences
Kathleen M. Mulder, Ph.D. (SUNY at Buffalo), Professor of Biochemistry and Molecular Biology
Joshua E. Muscat, Ph.D., M.P.H. (New York University), Professor of Public Health Sciences
Christopher C. Norbury, Ph.D. (University of Dundee), Professor of Microbiology and Immunology
Leslie J. Parent, M.D. (Duke University), Professor of Medicine, and Microbiology and Immunology
Blaise Z. Peterson, Ph.D. (University of Washington), Associate Professor of Cellular and Molecular Physiology
Rebecca Phaeton, M.D. (Marshall University), Assistant Professor of Obstetrics and Gynecology, and Microbiology and Immunology
David S. Phelps, Ph.D. (Temple University), Professor of Pediatrics
Jeffrey J. Pu, M.D., Ph.D. (New York Medical College), Assistant Professor of Medicine
Ziaur Rahman, M.D., Ph.D. (National University of Singapore), Associate Professor of Microbiology and Immunology
John P. Richie Jr., Ph.D. (University of Louisville), Professor of Public Health Sciences, and Pharmacology
Dear Ralph,

I am happy to provide consultation regarding the proposed changes in the BMS Graduate Program at the College of Medicine (COM). I am very familiar with the BMS Graduate Program, and I have been involved in the program since its inception. Several of the graduate students I am mentoring in my laboratory are enrolled in the program. The establishment of the BMS Graduate Program as our signature graduate program has been transformative at the COM. In fact, as I recall, the program has been lauded at the national level, with you receiving the 2012 AAMC Innovations in Research and Research Education Award for your redesign of the BMS Core Curriculum.

With respect to the addition of the Cellular and Integrative Physiology as an Option, I am fully in support of this change. This is a critical update that will offer the opportunity for students to pursue graduate studies in physiology at the College of Medicine. As you are aware, in April 2016, the Physiology Intercollege Graduate Degree Program (IGDP) submitted a program change to the graduate school to extend the Physiology IGDP option to the COM. The addition of Cellular and Integrative Physiology as an Option in BMS is therefore a necessary path for students who desire to focus their graduate studies in physiological studies and to pursue research in physiology research laboratories at the COM.

I am also in favor of the changes in the Core Curriculum, including the requirement for BMS 801, which provides instruction and practice in generating hypotheses and writing grant proposals. I am an advocate of having all eligible students write and submit NIH NRSA fellowship applications because of the value in learning how to communicate scientific ideas. This course will better prepare the students to think critically about their work, to design hypothesis-driven experiments logically, and to express their ideas clearly. If our graduate students have a greater degree of success in obtaining NIH fellowships, then the students, mentors, graduate degree programs, and the institution will benefit. I also support the curricular changes for the Biochemistry & Molecular Genetics and Virology & Immunology options, as described in your proposal.

The proposed requirement for MD/PhD students to take BMS 512 (Data Analysis for the Biomedical Laboratory Scientist) is important to prepare future physician-scientist to conduct quantitative research involving large data sets. Ensuring that MD/PhD students leave graduate school with an understanding of how to analyze “big data” has been discussed at the national level in professional meetings. As Co-Director of the MD/PhD Program, I am fully in support of this requirement. I believe this change will strengthen our training program, which has recently received an NIH T32 Training Grant. We are now designated as an Medical Scientist Training Program (MSTP), one of approximately 47 NIH funded programs in the US.

I fully support the requirement that students have at least one first-author publication based on their own research accepted for publication prior to the final oral thesis defense. This requirement is for the benefit of our students. Students learn a great deal by completing a set of experiments, writing a manuscript, participating in the review process, and successfully responding to critiques. Moreover, having a published manuscript will make students much more competitive for...
jobs in research, teaching, scientific writing, and other science-related areas. Based on national
data from MD/PhD programs in the US, approximately 60% of programs require at least one
published manuscript (and some require two publications) prior to graduation. In some cases, the
publication requirement was based on the policy of the graduate school and was not unique to the
joint degree program.

I wish you success in your application to the Graduate School for these important proposed
changes to the BMS Graduate Program.

Best regards,

Leslie

Leslie J. Parent, M.D.
Vice Dean for Research & Graduate Studies
Associate Vice President for Health Sciences Research
Co-Director, Medical Scientist training Program (MSTP)
Professor of Medicine and Microbiology & Immunology,
Division of Infectious Diseases

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http://www.pennstatehershey.org/web/mdphd/home
Consultation from Kent Vrana, Ph.D.; Chair, Department of Pharmacology

Ralph -
I am fully supportive of the proposed changes in the BMS program. In particular, we have had a need for a curriculum option focused on physiology. Our efforts to include our physiology colleagues under the existing Options structure has proven ineffectual. As to the publication requirement, faculty members in the Department of Pharmacology have long supported an informal requirement for two first-author papers submitted, accepted, or published prior to the acceptance of the dissertation. This change formalizes this requirement to some extent, although I anticipate that faculty members in the department will still advocate that their students have two first-author manuscripts. In that spirit, it is vitally important that this requirement for one paper is the minimal standard and cannot be interpreted by a student as being all that is required. I think this can be handled at the level of student's mentor and committee (i.e., they can determine that a three figure paper in a lower tier journal is an insufficient body of scholarly work for a dissertation), but it needs to be acknowledged and perhaps codified in the student manual.

Well done, Ralph, and kudos to the committee for their hard work.

Cheers,
Kent

Kent E. Vrana, PhD
Elliot S. Vesell Professor and Chair of Pharmacology
Consultation from Bob Levenson Ph.D.; Co-Director, Medical Scientist (M.D./Ph.D.) Training Program

From: Levenson, Robert rlevenson@hmc.psu.edu
Subject: Proposed changes to BMS program
Date: August 11, 2016 at 3:06 PM
To: Keil, Ralph rlk9@psu.edu
Cc: Parent, Leslie lparent@hmc.psu.edu

Dear Ralph:
I have read over your proposed changes to the BMS program, and am highly supportive of Item 1) adding Cellular and Integrative Physiology as an Option (page. 2), and Item 3) having a one first-author publication requirement (page 3).

These changes are especially important for MD/PhD students as well as any graduate student who may be considering joining the BMS program. I am very supportive of adding Cellular and Integrative Physiology as an option in the BMS program since this option is extremely relevant to MD/PhD students who may be interested in carrying out their thesis research in areas related to normal physiological processes and/or the pathophysiology of human disease. I am also extremely supportive of the idea that all graduate students (including MD/PhD students) have at least one-first author peer-reviewed manuscript as a requirement for graduation. This requirement is especially important for MD/PhD students, as their ability to match into a top-tier research oriented residency program or to obtain a highly competitive postdoc position will depend in large part on their research productivity, as evidenced by their publication record. According to a survey we conducted last year, over 60% of all US MD/PhD programs require a minimum of 1 publication for graduation. It is also abundantly clear from the last several MD/PhD directors meetings, that having a minimum paper requirement will be essential for programs seeking to obtain MSTP status or maintain their MSTP (NIH-funded) MD/PhD programs. For these reasons, I highly support your proposed changes to the BMS program.

Sincerely,
Bob

Robert Levenson
Distinguished Professor of Pharmacology
and of Neural and Behavioral Sciences
Co-Director, MSTP (Medical Scientist Training Program)
Penn State College of Medicine
Hershey, PA 17033
Email: rlevenson@hmc.psu.edu
Voice: (717) 531-4545
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http://profiles.psu.edu/profiles/ProfileDetails.aspx?From=SE&Person=1237
Consultation from Jennifer Baccon, M.D./Ph.D.; Associate Director, Medical Scientist Training Program

Dear Ralph,

Thank you for requesting my consultative opinion on the proposed changes to the BMS Graduate program.

I am in support of all 3 of the categories of proposed changes detailed in the Program Changes document for the reasons outlined here:

1) Adding Cellular and Integrative Physiology as an option will be beneficial to students studying physiology and pathophysiology, and will help tailor their educational experience to closely match their research interests. This will be a benefit for both the MD/PhD and PhD students.

2) All of the proposed curricular changes will enhance the curriculum. As an instructor in portions of the core curriculum, I have had the opportunity to see how the changes benefit the students. And in particular, item “g” addresses the needs for the MD/PhD students to become familiar with data analysis, particularly large data sets, and at the same time this curricular change avoids unnecessary redundancy in the curriculum. I am delighted to see that all the changes within this category focus on the educational needs of our students in training. The changes are thoughtful and keep in mind what the graduating PhD scientists of today and tomorrow will need in terms of skills as they enter the workforce. My compliments on addressing the often difficult challenge of consolidating course work and deciding what we no longer need to teach.

3) The one first-author publication requirement will be a true benefit for our students, and for Penn State. It is a bar that is common for programs across the country, particularly MD/PhD programs, and by making this change, we place ourselves in the majority in terms of MD/PhD programs with a similar requirement (a survey that our MD/PhD program conducted last year showed that 60% of all US MD/PhD programs require a minimum of 1 publication for graduation). Additionally, we recently received MSTP funding from the NIH, and it is clear that we will need to demonstrate that we have a minimum paper requirement for successful renewal of that award. In that sense, this change is truly no optional. We must move forward with it.

Again, I extend my sincere thanks and congratulations on thoughtfully constructing these proposed changes to the BMS Graduate Program that will enhance our program and benefit our students. I am in full support of the proposed changes.

Sincerely yours,

Jennifer Baccon, MD, PhD
Associate Professor
Departments of Pathology and Neurosurgery
Director of Foundational Medical Sciences
Director of Pathology Undergraduate Medical Education
Associate Director, MD/PhD Program
Penn State Health Milton S. Hershey Medical Center
Penn State College of Medicine
Mail Code H179
500 University Drive
Hershey, PA 17033
Tel: 717-531-8102
Consultation from Aron Lukacher, M.D./Ph.D.; Chair, Department of Microbiology and Immunology; Associate Director, Medical Scientist Training Program

Dear Ralph,

As you know from our many discussions on this topic, I am strongly supportive of the requirement for a graduate student to have at least one first-author primary research manuscript accepted for publication in a peer-reviewed journal prior to their PhD dissertation defense. The process of shepherding a manuscript from original submission, responding to reviewer critiques, and revising a scientific manuscript are integral components of a graduate student education. At Penn State and at my former institution (Emory), both MD/PhD programs were in fact required by the reviewers to include such a manuscript requirement to even be considered for an MSTP grant. As a previous director of a T32 funded grant program, and having spent my entire faculty career deeply involved in graduate education, I completely understand the pro and con sides of this issue, particularly the major concern about a potential delay in a student’s defense date and a pending manuscript acceptance. However, between a student's thesis committee, mentor, and the graduate program, this concern (in my experience) can be mitigated.

I am also supportive of creating a new Cellular and Integrative Physiology option. I feel that such an option will (1) increase the number of applications to the BMS graduate program and (2) be of interest to current MD/PhD students who are considering training and careers focused on the physiologic aspects of health and disease process.

For these reasons, I am highly supportive of both of these proposed changes to the BMS Program.

Sincerely,

Aron

Aron Lukacher, M.D., Ph.D.
Professor and Chair
Department of Microbiology and Immunology, H107
Penn State College of Medicine
500 University Drive
Hershey, PA 17033
Office: (717) 531-6521
Fax: (717) 531-6522
alukacher@hmc.psu.edu
Consultation from Gail Thomas, Ph.D.; Co-Director, Clinical and Translational Science Institute TL1 Program

Dear Ralph,

Thank you for the opportunity to review and comment on the proposed changes to the BMS Graduate Program. I am pleased to see that you are proposing to add a new Option in Cellular and Integrative Physiology (CIP). There is increasing recognition that we are not training a sufficient number of integrative physiologists to fill the collective demands of academia, industry, and government. Many physiology programs across the country have ceased to exist or have become overwhelmingly molecular in focus, reflecting the training and interests of their faculty. Your new CIP option will offer students the opportunity to receive rigorous training in the labs of a substantial number of faculty at the College of Medicine who focus on understanding the interactions among cells, tissues, and organs in order to gain insight into both health and disease mechanisms.

I also am pleased to see the addition of a required course in grant writing (BMS 801) for all BMS students as this addresses numerous skills that are invaluable for PhD scientists in many occupations. In general, the proposed changes to emphasize learning concepts rather than facts and to enhance self-directed learning are viewed as positive steps that permit students to take greater responsibility for their graduate education.

Finally, I think that the new requirement for a first-author publication stemming from the student’s dissertation research prior to the final oral exam is an appropriate scholarly achievement that we should expect from all of our students. This requirement will help reinforce the concept that the evolution of science relies as much on dissemination of knowledge through publication as it does on creation of that knowledge. The feedback received from review of a manuscript also should prove useful for the student in writing and defending his or her dissertation. Having at least one first-author publication should also make the student a more attractive candidate for future career opportunities. It also is an important metric for institutional training grant applications to show the strength of the training faculty.

Please let me know if I can be of any further help to the BMS program. I look forward to seeing the proposed program changes implemented in the near future.

Best regards,

Gail

Gail D. Thomas, Ph.D.
Heart and Vascular Institute, Room C6522
717-531-0003, ext. 287087
gthomas4@hmc.psu.edu
Dear Dr. Keil:

It is with much enthusiasm and that I write to provide my strongest support for the changes that are proposed for the Biomedical Sciences (BMS) Graduate Program in order to enhance and strengthen the Program. The BMS Advisory Committee has carefully put together these changes with close consultation with the many members of the BMS Program.

As Chair of the Department of Cellular and Molecular Physiology, I write on behalf of all the faculty members in this Department as well as our many affiliated faculty, to express our greatest support for creation of the new Option in Cellular and Integrative Physiology (CIP) within the BMS Graduate Program. This new research training initiative is of paramount importance to the research mission of our expanding and newly focused Department, and is a crucial complementation to the research training scope of the BMS Program as well as our other existing graduate programs.

Since joining the Department of Cellular and Molecular Physiology in February 2014, we have hired a total of eight new faculty members in the Department. Our mission has been to build highly collaborative research with a strong emphasis on cellular and molecular approaches to understanding the physiological basis of disease. The proposed CIP Option provides the graduate training environment that is an integral part of our new initiative in translational research. Until recently, our Department undertook research that was more within the traditional boundaries of Physiology, and our Department had enjoyed a strong interaction with the cross-campus Inter-Departmental Graduate Program in Physiology. However, our Department has undergone a major research transition to focus on molecular paradigms and cellular pathophysiology of a spectrum of disease states. While our Department research focus has transitioned, the scope of our new molecular and cellular emphasis within the proposed CIP Option, greatly complements and extends, but does not duplicate, the interests of the IDGP in Physiology.

Our newly proposed CIP Option focuses on training in a number of important new research areas including, (a) intracellular signaling mechanisms in tissue remodeling and
cancer, (b) the molecular basis of metabolic disease and its relationship to diabetes and cancer, (c) the regulation of contractile machinery in relation to the onset of cardiac and skeletal muscle diseases, and (d) the cellular changes and remodeling that occur in vascular, lung and renal disease states. Our research interests have strong connections with and provide important complementation with the other basic science Departments here at Hershey, including close interactions with the Heart and Vascular Institute, the Cancer Institute, as well as the Departments of Surgery, Medicine, and Ophthalmology. We are undertaking some joint hiring with these divisions and departments and many of our new faculty have strong cross-disciplinary interactions with the other basic science Departments that contribute to the BMS Graduate Program. The CIP option is therefore a crucial forum within which we can foster strong collaborative research training initiatives and promote research collaborations not only within the Hershey campus, but also with the strong new research interactions being fostered between our campus and University Park.

Creation of the new CIP option is therefore one of the most crucial new developments in graduate training to have emerged since the initiation of the BMS Graduate Program on our campus. I also wish to stress our universal support for yet another important issue in the current BMS Graduate Program proposal, namely, the requirement for at least one first-authored paper before graduation. I believe that research quality and productivity are the hallmarks of success of a program. I have always operated in graduate programs where at least one or two first-author publications were required of students. I believe that, in addition to ensuring the success of the student, such publication requirement protects the prestige and success of the program. I consider incoming quality students would consider a program in which students need not necessarily publish their results, as one that they might prefer to avoid. We need to have a sustained record of success from our students to attest to their outstanding training within our Program.

We thank the committee members for carefully considering the strength of our proposed amendments to enhance the BMS Graduate Program.

Sincerely yours,

Donald L. Gill, Ph.D.
Professor and Chair
Department of Cellular and Molecular Physiology
Penn State University College of Medicine
Hi Ralph,

I have no real comments on your proposed program changes.

We get BMS students working in NBS and it is important that they can use their elective courses to gain a working knowledge of neuroscience. It looks as though that is possible in your curriculum.

Best regards,

Colin

Colin J. Barnstable, D.Phil.
Professor and Chair, Department of Neural and Behavioral Sciences
Professor of Psychiatry
Research Director, Penn State Hershey Eye Center
August 22 2016

Ralph Keil, PhD, Chair
Biomedical Sciences Graduate Program
The Pennsylvania State University

Dear Ralph,

Thank you for the opportunity to consult on the 2016 BMS program proposal. The documents provided are extremely thorough. Three modifications to the program are requested:

1) add the Cellular and Integrative Physiology (CIP) Option to the Biomedical Sciences (BMS) Graduate Program,

2) modify the required curriculum of the BMS Graduate Program, and

3) add a requirement for at least one first-author publication accepted or published based on the student’s dissertation research prior to the final oral examination.

My consultation is based on my experiences as a co-director for our dual-title PhD in Clinical and Translational Sciences (CTS), and as a member and course director in the IGDP in Integrative and Biomedical Physiology (formerly Physiology). I will address both perspectives separately.

**CTS Perspective**

I believe the proposed changes to the BMS will have positive effects on the CTS dual-title PhD program. Operationally there is no negative impact whatsoever from change #1 and #2. To the contrary, the proposed new courses support the Scientific Writing, Bioinformatics and Experimental Design components of the CTS elective course curriculum. The new option may help with recruiting students who are more likely to enroll in the CTS dual-title PhD program. The proposed CIP option provides considerable flexibility; students should encounter minimal difficulty adopting this option and CTS.

Change #3 is forward thinking. Since graduates will be communicating through research papers for their entire career, the proposed change provides an additional opportunity to guide students in their professional education and training. CTS students have been very
assertive with writing papers during their tenure, so we anticipate that this proposed change will simply reinforce our educational expectations.

**Integrative and Biomedical Physiology IGDP Perspective**

My comments are those of a member of the IGDP faculty and should in no way be construed as representative of the Integrative and Biomedical Physiology IGDP as a whole. I encourage you to consult with the program head (Donna Korzick) for a broader programmatic point of view.

Change #1 and #2 create a new Cellular and Integrative Physiology (CIP) option within the BMS program. The proposed CIP option replicates many of the program features found in the IGDP in Integrative and Biomedical Physiology. Nevertheless, the proposed change to BMS fills a void in physiology training that was created since the Hershey campus is no longer part of the IGDP; the two programs the IGDP and the CIP option should be seen as complementary. The proposed program change should be more responsive to the needs of graduate students on the Hershey campus. Moreover, this structure makes it easier to evolve the IGDP and the CIP option over time to better meet the needs of their respective campuses.

The proposed CIP option includes two required physiology courses (PSIO 504 and 505). For many years the responsibilities for these courses have been shared with the UP campus, cross-listed as PHSIO 571 and PHSIO 572. Although there is a long history of successful collaborative team teaching PSIO 504/505 & PHSIO 571/572, with the UP and Hershey campuses contributing equally, this model appears to have run its useful course and is no longer a practical approach if both campuses are not participating in the IGDP.

In summary, I am supportive of all the proposed changes. I believe they will add to the success of the CTS dual-title PhD, and create new opportunities to develop skills in physiological inquiry at the Hershey campus.

Please do hesitate to contact me if you have further questions.

Sincerely,

Jim Pawelczyk, Ph.D.

Associate Professor of Physiology and Kinesiology
Co-Director, Dual-title PhD in Clinical and Translational Sciences
IX.VII. Attachments

Attachment A1: Current curricular table from the Student Handbook for the Ph.D. degree in the BMS Graduate Program and its Options

Attachment A2: Proposed curricular table for the Student Handbook for the Ph.D. degree in the BMS Graduate Program and its Options

Attachment B1: Current curricular table from the Student Handbook for the M.S. degree in the BMS Graduate Program and its Options

Attachment B2: Proposed curricular table for the Student Handbook for the M.S. degree in the BMS Graduate Program and its Options

Attachment C1: Current curricular table from the Student Handbook for the M.D./Ph.D. degree in the BMS Graduate Program and its Options

Attachment C2: Proposed curricular table for the Student Handbook for the M.D./Ph.D. degree in the BMS Graduate Program and its Options.
### Table 1: Typical Coursework Schedule for Ph.D. Degree for the Four Curricular Tracks: Years 1 and 2

<table>
<thead>
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<th>BMG OPTION TRACK</th>
<th>TT OPTION TRACK</th>
<th>VIRIM OPTION TRACK</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 Credits</td>
<td>13 Core Requirement Credits</td>
<td>10 Program Required Credits</td>
<td>13 Core Requirement Credits</td>
<td>13 Core Requirement Credits</td>
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<tr>
<td>10 Program Required Credits</td>
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#### Fall Year 1 (11 credits)

<table>
<thead>
<tr>
<th>Course Requirement</th>
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<tbody>
<tr>
<td>Core (3) BMS 501 Regulation of Cellular &amp; Systemic Energy Metabolism (3)</td>
</tr>
<tr>
<td>Core (3) BMS 502 Cell &amp; Systems Biology (3)</td>
</tr>
<tr>
<td>Core (1) BMS 596 Individual Studies: Research Rotation (1)</td>
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#### Fall Year 2 (2 to 8 credits)

<table>
<thead>
<tr>
<th>Course Requirement</th>
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</thead>
<tbody>
<tr>
<td>Option Specific (PROGRAM ELECTIVE)</td>
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<td>Option Specific (PROGRAM ELECTIVE)</td>
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#### Spring Year 1 (6 to 9 credits)

<table>
<thead>
<tr>
<th>Course Requirement</th>
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</thead>
<tbody>
<tr>
<td>Core Requirement (1) BMS 505 Art of Scientific Communication II (1)</td>
</tr>
<tr>
<td>Core Requirement (1) BMS 506 Individual Studies: Research Rotation (1)</td>
</tr>
<tr>
<td>Option Specific BCSM 520 Integrative Physiology (3)</td>
</tr>
<tr>
<td>Option Specific BCSM 522 Molecular Genetics: Genes to Genomes (3)</td>
</tr>
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</table>

#### Spring Year 2 (2 to 8 credits)

<table>
<thead>
<tr>
<th>Course Requirement</th>
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</thead>
<tbody>
<tr>
<td>Option Specific (PROGRAM ELECTIVE)</td>
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<tr>
<td>Option Specific (PROGRAM ELECTIVE)</td>
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</tbody>
</table>

#### Comprehensive Exam

1. The minimum number of elective credits required is shown. In consultation with their Dissertation Adviser, students may take additional credits. One potential timing of elective credits for each track is indicated by "PROGRAM ELECTIVE".
2. To complete the Journal Club elective, VIRIM students must register either for IBIOS 580 Critical Readings in Immunology (1) in the Fall semester or MICRO 572 Virology Literature Report (1) in the Spring semester.

Numbers in parentheses indicate credit hours for each course.
## Table 1: Typical 'Core' and Track-Specific Coursework Schedule for the Ph.D. Degree: Years 1 and 2

<table>
<thead>
<tr>
<th>Required credits</th>
<th>BMG OPTION TRACK</th>
<th>BMS PROGRAM TRACK</th>
<th>CIP OPTION TRACK</th>
<th>TT OPTION TRACK</th>
<th>VIRIM OPTION TRACK</th>
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</thead>
<tbody>
<tr>
<td>17 Core Requirement Credits</td>
<td>17 Core Requirement Credits</td>
<td>17 Core Requirement Credits</td>
<td>17 Core Requirement Credits</td>
<td>17 Core Requirement Credits</td>
<td>17 Core Requirement Credits</td>
</tr>
<tr>
<td>2 BMG Required Credits</td>
<td>10 BMG Option Required Credits</td>
<td>11 CIP Option Required Credits</td>
<td>11 TT Option Required Credits</td>
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<tr>
<td>10 Elective Credits</td>
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### Fall Year 1

<table>
<thead>
<tr>
<th>Core Requirement</th>
<th>BMG 502 Cell &amp; Systems Biology (3)</th>
<th>BMS 502 Cell &amp; Systems Biology (3)</th>
<th>BMS 502 Cell &amp; Systems Biology (3)</th>
<th>BMS 502 Cell &amp; Systems Biology (3)</th>
<th>BMS 502 Cell &amp; Systems Biology (3)</th>
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<tbody>
<tr>
<td>Option Specific</td>
<td>BCHEM 522 Molecular Genetics: Genes to Genomes (3)</td>
<td>PSIO 504 Cellular and Integrative Physiology (3)</td>
<td>PHARM 520 Principles of Drug Action (2)</td>
<td>MICRO 581 Immunology A: Basic Concepts in Innate &amp; Adaptive Immunology (1)</td>
<td>MICRO 582 Immunology B: Adaptive Immunology (1)</td>
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### Spring Year 1

<table>
<thead>
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<th>BM 505 Art of Scientific Communication (1)</th>
<th>BM 505 Art of Scientific Communication (1)</th>
<th>BM 505 Art of Scientific Communication (1)</th>
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<th>BM 505 Art of Scientific Communication (1)</th>
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<tbody>
<tr>
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<td>BM 590 Colloquium^* (1)</td>
<td>BM 590 Colloquium^* (1)</td>
<td>BM 590 Colloquium^* (1)</td>
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### Fall Year 2

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<th>BM 591 Ethics (1)</th>
<th>BM 591 Ethics (1)</th>
<th>BM 591 Ethics (1)</th>
<th>BM 591 Ethics (1)</th>
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<tbody>
<tr>
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<td>BM 596 Individual Study: Research (2)</td>
<td>BM 596 Individual Study: Research (2)</td>
<td>BM 596 Individual Study: Research (2)</td>
<td>BM 596 Individual Study: Research (2)</td>
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<td>BM 801 Writing Grant Proposals for Biomedical Research (1)</td>
<td>BM 801 Writing Grant Proposals for Biomedical Research (1)</td>
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<tr>
<td>Option Specific</td>
<td>PSIO 501 Scientific Analysis and Presentation (1)</td>
<td>PSIO 501 Scientific Analysis and Presentation (1)</td>
<td>PSIO 501 Scientific Analysis and Presentation (1)</td>
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<td>PHARM 551 Anti-infective Therapies (1)</td>
<td>PHARM 551 Anti-infective Therapies (1)</td>
<td>PHARM 551 Anti-infective Therapies (1)</td>
<td>PHARM 551 Anti-infective Therapies (1)</td>
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<tr>
<td>Option Specific</td>
<td>PHARM 553 Gastrointestinal &amp; Immunomodulatory Therapeutics (1)</td>
<td>PHARM 553 Gastrointestinal &amp; Immunomodulatory Therapeutics (1)</td>
<td>PHARM 553 Gastrointestinal &amp; Immunomodulatory Therapeutics (1)</td>
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<td>Option Specific</td>
<td>PHARM 554 Anticancer Therapies (1)</td>
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### Spring Year 2

<table>
<thead>
<tr>
<th>Core Requirement</th>
<th>BM 590 Colloquium^* (1)</th>
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<tr>
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<td>Option Specific</td>
<td>PSIO 501 Scientific Analysis and Presentation (1)</td>
<td>PSIO 501 Scientific Analysis and Presentation (1)</td>
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<td>PSIO 501 Scientific Analysis and Presentation (1)</td>
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<tr>
<td>Option Specific</td>
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<td>PHARM 556 Neuropharmacology (2)</td>
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<td>PHARM 556 Neuropharmacology (2)</td>
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<tr>
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</tbody>
</table>

### Candidacy Examination

Decision regarding Program or Option Enter dissertation research lab

### Comprehensive Exam

Numbers in parentheses indicate credit hours for each course.

1. The minimum number of elective credits required is shown. In consultation with their Dissertation Adviser, students may take additional credits. Since electives are taken during various semesters depending on when classes of interest are offered, the times for elective credits are not shown. Elective credits can include BM 500 Foundations of Biomedical Research. BM 596, beyond the 2 credits of the ‘Core Requirement’, do not count toward elective credits. BM 600, 601, 610, or 611 credits do not count toward required elective credits.

2. All BM students sign up for 1 credit of BM 590 each spring. Students who have not passed the comprehensive exam sign up for a grade. Students who have passed the comprehensive sign up for Audit.

3. The Colloquium requirements for the BMG Program Track can be satisfied by BCHEM 590, PSIO 501, PHARM 590, MICRO 590, MICRO 572, or VIRIM 580.

4. To complete the VIRIM Journal Club requirement, VIRIM students must register either for VIRIM 580 Critical Reading in Immunobiology or MICRO 572 Virology Literature Reports.

5. VIRIM students take either 1) BM 564 or MICRO 560 and 2) BM 562 or BM 564. These choices must be made in consultation with the student’s dissertation advisor.
### Core Requirement Credits

13 Credits

<table>
<thead>
<tr>
<th>CORE REQUIREMENTS FOR ALL STUDENTS</th>
<th>13 Core Requirement Credits</th>
<th>10 Program Required Credits</th>
<th>6 BMS 600 Credits</th>
<th>1 Elective Credit¹</th>
<th>6 BMS 600 Credits</th>
<th>1 Elective Credit¹</th>
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<tr>
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</table>

### Table 2: Typical Coursework Schedule for the M.S. Degree for the Four Curricular Tracks

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<tr>
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<th>1 Elective Credit¹</th>
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<th>1 Elective Credit¹</th>
</tr>
</thead>
</table>

#### Fall Year 2 (2 to 8 credits)

<table>
<thead>
<tr>
<th>Option Specific</th>
<th>BMS 591 Ethics (1)</th>
<th>BCHEM 590 Colloquium (1)</th>
<th>PHARM 554 Anti-infective Therapeutics (1)</th>
<th>MICRO 553 Science of Virology (4)</th>
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#### Spring Year 2 (2 to 8 credits)

<table>
<thead>
<tr>
<th>Option Specific</th>
<th>BMS 581 Molecular &amp; Translational Approaches to Human Disease (3)</th>
<th>PHARM 561 Neuropharmacology (2)</th>
<th>MICRO 560 Concepts in Immunology (4)</th>
</tr>
</thead>
</table>

### Decision regarding Program or Option; Enter laboratory for thesis research

#### Fall Year 2 (2 to 8 credits)

<table>
<thead>
<tr>
<th>Core Requirement</th>
<th>13 Core Requirement Credits</th>
<th>10 Program Required Credits</th>
<th>6 BMS 600 Credits</th>
<th>1 Elective Credit¹</th>
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<th>TT OPTION TRACK</th>
<th>VIRIM OPTION TRACK</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Core Requirement</strong></td>
<td>BMS 502 Cell &amp; Systems Biology (3)</td>
<td>BMS 502 Cell &amp; Systems Biology (3)</td>
<td>BMS 502 Cell &amp; Systems Biology (3)</td>
<td>BMS 502 Cell &amp; Systems Biology (3)</td>
<td>BMS 502 Cell &amp; Systems Biology (3)</td>
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<td>BMS 564 Art of Scientific Communication I (1)</td>
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<td>BMS 564 Art of Scientific Communication I (1)</td>
<td>BMS 564 Art of Scientific Communication I (1)</td>
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<tr>
<td><strong>Core Requirement</strong></td>
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<td>BMS 505 Art of Scientific Communication II (1)</td>
<td>BMS 505 Art of Scientific Communication II (1)</td>
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</tr>
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<td>BMS 590 Colloquium 2  (1)</td>
<td>BMS 590 Colloquium 2  (1)</td>
<td>BMS 590 Colloquium 2  (1)</td>
<td>BMS 590 Colloquium 2  (1)</td>
<td>BMS 590 Colloquium 2  (1)</td>
</tr>
<tr>
<td><strong>Option Specific</strong></td>
<td>BCHEM 522 Molecular Genetics: Genes to Genomes (3)</td>
<td>PSIO 504 Cellular and Integrative Physiology (3)</td>
<td>PHARM 520 Principles of Drug Action (2)</td>
<td>MICRO 581 Immunology A: Basic Concepts in Innate &amp; Adaptive Immunology (1)</td>
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<td></td>
<td>BMS 512 Data Analysis for the Biomedical Lab Scientist (2)</td>
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<td>MICRO 582 Immunology B: Adaptive Immunology (1)</td>
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<tr>
<td><strong>Option Specific</strong></td>
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<td></td>
<td>BMS 562 Principles of Immunology C: Dysfunction &amp; Manipulation of the Immune System (1)</td>
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<tr>
<td><strong>Option Specific</strong></td>
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<td>MICRO 550 (2) Medical Microbiology: Topics in Molecular Pathogenesis</td>
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**Decision regarding Program or Option**
**Enter thesis research lab**

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<td><strong>Core Requirement</strong></td>
<td>BMS 591 Ethics (1)</td>
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<td>Colloquium 2  (1)</td>
<td>BCHEM 590 Colloquium (1)</td>
<td>PSIO 501 Scientific Analysis and Presentation (1)</td>
<td>PHARM 551 Anti-infective Therapeutics (1)</td>
<td>VIRIM Journal Club* (1)</td>
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<td>PHARM 552 Integrated Systems Pharm (1)</td>
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<td>BMS 564 Concepts in Virology (2)</td>
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<td>PHARM 553 Gastrointestinal &amp; Immunomodulatory Therapeutics (1)</td>
<td>BMS 564 Viral Oncogenesis (1)</td>
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<td>PHARM 554 Anticancer Therapeutics (1)</td>
<td>BMS 567 Viral Pathogenesis (1)</td>
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<td>BCHEM 590 Colloquium (1)</td>
<td>PSIO 501 Scientific Analysis and Presentation (1)</td>
<td>PHARM 559 Colloquium (1)</td>
<td>MICRO 560 Concepts in Immunology (2)</td>
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<td>MICRO 560 Concepts in Immunology (2)</td>
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<td>PHARM 561 Neuropsychopharmacology (2)</td>
<td>MICRO 590 Colloquium (1)</td>
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<td>PHARM 562 Endocrine Pharmacology (2)</td>
<td>GENET 581 Genetics of Model Organisms: A Bacterial and Viral Pathogenesis (1)</td>
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</tbody>
</table>

Numbers in parentheses indicate credit hours for each course.

1 The minimum number of elective credits required is shown. In consultation with their Thesis Adviser, students may take additional credits. Since electives are taken during various semesters depending on when classes of interest are offered, the times for elective credits are not shown. Elective credits can include BMS 500 Foundations of Biomedical Research. BMS 596, beyond the 2 credits of the 'Core Requirement', do not count toward elective credits. BMS 600, 601, 610, or 611 credits do not count toward required elective credits.

2 The Colloquium requirements for the BMS Program Track can be satisfied by BCHEM 590, PSIO 501, PHARM 590, MICRO 590, MICRO 572, or VIRIM 580.

3 All BMS M.S. students sign up for 1 credit of BMS 590 each Spring and take it for a grade.

4 To complete the VIRIM Journal Club requirement, VIRIM students must register either for VIRIM 580 Critical Reading in Immunobiology or MICRO 572 Virology Literature Reports.

5 VIRIM students take either 1) BMS 564 or MICRO 560 and 2) BMS 562 or BMS 564. These choices must be made in consultation with the student's thesis adviser.
### Table 3: Typical Coursework Schedule for the M.D./Ph.D. Degree for the Four Curricular Tracks: Years G1 and G2

<table>
<thead>
<tr>
<th>COURSES</th>
<th>BMS PROGRAM TRACK</th>
<th>BMG OPTION TRACK</th>
<th>TT OPTION TRACK</th>
<th>VIRIM OPTION TRACK</th>
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<tbody>
<tr>
<td>Required Credits</td>
<td>15 Core Requirement Credits</td>
<td>15 Core Requirement Credits</td>
<td>15 Core Requirement Credits</td>
<td>15 Core Requirement Credits</td>
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<tr>
<td>Core Requirement (12) MEDICAL SCHOOL</td>
<td>CMBMP 711 and 712 (12)</td>
<td>CMBMP 711 and 712 (12)</td>
<td>CMBMP 711 and 712 (12)</td>
<td>CMBMP 711 and 712 (12) [BBD 716 (6) completed as part of M1]</td>
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<tr>
<td>COURSES (taken in year M1): replace</td>
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<tr>
<td>BMS 501, 502, 503, and 596</td>
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<tr>
<td>Core Requirement (1)</td>
<td>BMS 504 Art of Scientific Communication I (1)</td>
<td>BMS 504 Art of Scientific Communication I (1)</td>
<td>BMS 504 Art of Scientific Communication I (1)</td>
<td>BMS 504 Art of Scientific Communication I (1)</td>
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<tr>
<td>Option Specific (PROGRAM ELECTIVE)</td>
<td>BCHEM 521 Structure, Function, &amp; Regulation of Biological Molecules (3)</td>
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<td>MICRO 553 Science of Virology (4)</td>
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<tr>
<td>Core Requirement (1)</td>
<td>BMS 591 Ethics (1)</td>
<td>BMS 591 Ethics (1)</td>
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<tr>
<td>Option Specific (PROGRAM ELECTIVE)</td>
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<tr>
<td>Core Requirement (1)</td>
<td>BMS 505 Art of Scientific Communication II (1)</td>
<td>BMS 505 Art of Scientific Communication II (1)</td>
<td>BMS 505 Art of Scientific Communication II (1)</td>
<td>BMS 505 Art of Scientific Communication II (1)</td>
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<td>Option Specific</td>
<td>BMS 581 Molecular &amp; Translational Approaches to Human Disease (3)</td>
<td>BCHEM 522 Molecular Genetics: Genes to Genomes (3)</td>
<td>PHARM 520 Principles of Drug Action (2)</td>
<td>MICRO 560 Concepts in Immunology (4)</td>
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<td>Comprehensive Exam</td>
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<td>Fall Year G1 (2 to 5 credits)</td>
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<td>Core Requirement (1)</td>
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<td>Spring Year G1 (1 to 4 credits)</td>
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<tr>
<td>Option Specific</td>
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</table>

1 The minimum number of elective credits required is shown. In consultation with their Dissertation Adviser, students may take additional credits. One potential timing of elective credits for each track is indicated by “PROGRAM ELECTIVE”.

2 To complete the Journal Club elective, VIRIM students must register either for IBIOS 580 Critical Readings in Immunology (1) in the Fall semester or MICRO 572 Virology Literature Reports (1) in the Spring semester.

Numbers in parentheses indicate credit hours for each course.
## Table 3: Typical Coursework Schedule for the M.D./Ph.D. Degree: Years M1 to G2

<table>
<thead>
<tr>
<th>Required Credits</th>
<th>BMS PROGRAM TRACK</th>
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<td>14 Core Requirement Credits</td>
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<td>2 Program Required Credits</td>
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<td>6 MD/PhD Required Credits</td>
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<td>6 Elective Credits&lt;sup&gt;1&lt;/sup&gt;</td>
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</table>

<sup>1</sup> The minimum number of elective credits required is shown. In consultation with their Dissertation Adviser, students may take additional credits. Since electives are taken during various semesters depending on when classes of interest are offered, the times for elective credits are not shown. Elective credits can include BMS 500 Foundations of Biomedical Research. BMS 596, BMS 600, 601, 610, or 611 credits do not count toward required elective credits.

### Core Requirement (8) Medical courses taken in Years M1 & M2 replace the BMS core curriculum

### Spring Year M1
- MD/PhD Specific Elective

### Fall Year M2
- MD/PhD Specific BMS 506A Biological Basis of Human Health & Disease A (2)

### Spring Year M2
- MD/PhD Specific BMS 506B Biological Basis of Human Health & Disease B (2)
- End of M2 Year: USMLE Step 1 (replaces candidacy examination)
- Enter dissertation lab

### Fall Year G1
- Core Requirement BMS 591 Ethics (1)
- Core Requirement BMS 801 Writing Grant Proposals for Biomedical Research (1)
- Option Specific Colloquium<sup>2</sup> (1)

### Spring Year G1
- Core Requirement BMS 590 Colloquium<sup>2</sup> (1)
- MD/PhD Specific BMS 512 Data Analysis for the Biomedical Lab Scientist (2)
- Option Specific Colloquium<sup>3</sup> (1)

### Comprehensive examination

### Fall Year G2

### Spring Year G2
- Core Requirement BMS 590 Colloquium<sup>2</sup> (1)

---

Numbers in parentheses indicate credit hours for each course.

<sup>1</sup> All BMS students sign up for 1 credit of BMS 590 each Spring. Students who have not passed the comprehensive exam sign up for a grade. Students who have passed the comprehensive sign up for Audit.

<sup>2</sup> The Colloquium requirements for the BMS Program Track can be satisfied by BCHEM 590, PSIO 501, PHARM 590, MICRO 590, MICRO 572, or VIRIM 580.
Graduate Council
Program, Option, or Minor Proposal Form

Submit 1 original, signed Graduate Council proposal form and 2 hardcopies of the graduate program proposal document, with a copy of the signed proposal form attached to each proposal copy, to the Curriculum Coordinator, University Faculty Senate, 101 Kern Graduate Building, University Park. The proposals will be transmitted to the Office of the Dean of the Graduate School for entry into the Graduate Council curricular review process; for more information about the process, see the Overview of the Graduate Council Curricular Review Process.

The Program Proposal Procedures provide guidance for the development of a graduate program proposal. If you have questions regarding the preparation of a graduate program proposal or how to complete this Graduate Council proposal form, contact the Office of the Dean of the Graduate School.

College/School: College of Agricultural Sciences
Department or Instructional Area: Food Science

New Graduate Program, Option, or Minor: □ Add

Designation of new graduate program:
Classification of Instructional Programs (CIP) Code: ________
Designation of new graduate option:
Designation of new graduate minor:

Indicate effective semester:
□ First semester following approval
□ Second semester following approval

Existing Graduate Program Option, or Minor: □ Change □ Drop

Current designation of graduate program:
Current designation of graduate option:
Current designation of graduate minor:

New designation of existing graduate program (if changing):
New designation of existing graduate option (if changing):
New designation of existing graduate minor (if changing):

Brief description of the change (if not noted above): Proposal to adopt the International Agriculture and Development (INTAD) dual-title

Indicate effective semester:
□ First semester following approval
□ Second semester following approval

Submitted by Graduate Program Head
Robert Roberts
Printed name
Signature
Date: 4/16/16

Noted by College/School Representative to Graduate Council Subcommittee on New and Revised Programs and Courses:
John Ewing
Printed name
Signature
Date: 4/18/16

Approved by College/School Dean/Chancellor (or Designee):
Rama Radhakrishna
Printed name
Signature
Date: 9/21/2016
Recommended by Chair, Graduate Council Subcommittee on New and Revised Programs and Courses:

On Behalf of John Challis
Printed name
Signature
Date: 3/7/2017

Recommended by Chair, Graduate Council Committee on Programs and Courses:

On Behalf of M. Kathleen Heid
Printed name
Signature
Date: 3/7/2017

Noted by Dean of the Graduate School:

On Behalf of Regina Vasilatos-Younken
Printed name
Signature
Date: 3/7/2017
Food Science Graduate Degree Program
Department of Food Science
College of Agricultural Sciences (CAS)

Program Change: Food Science - adopt a dual-title degree in
International Agriculture and Development (College of Agricultural Sciences)
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JUSTIFICATION

Food is defined as any nutritious substance that people or animals eat or drink in order to maintain life and growth. As such, food is the ultimate goal of all agronomic systems. The Mission of the Department of Food Science is to provide science, education, and outreach contributing to an abundant supply of affordable, safe, nutritious, and appealing food. This challenge increases as the global human population continues to expand, global hunger remains a major issue, and foods are increasingly being shipped around the world. As a result, many food companies are now multi-national corporations that are looking for food science graduates who possess the ability to work effectively in international settings.

Both acute and chronic food-related diseases are growing problems around the world. In developing countries, contaminated food and water continue to cause significant morbidity and mortality due to acute infectious diseases. The application of modern food and water technologies that have greatly reduced these acute diseases in the developed world offers the opportunity to also greatly reduce the illness and death associated with these acute foodborne diseases in developing countries. However, while life expectancy continues to increase in developed countries, chronic diseases like heart disease, diabetes, and cancer are increasingly the cause of significant morbidity and mortality. New advances in our understanding of foodborne pathogens, the human microbiome, and bioactive compounds present in foods offer the potential to greatly reduce these acute and chronic diseases. The acute and chronic diseases associated with foods throughout the world pose huge burdens to both human health and economic well-being. Integrating the INTAD dual-title program with Penn State’s Center for Infectious Disease Dynamics and the strategic emphasis on Food Safety, the Human Microbiome, and Food Health and Wellness in the College of Agricultural Sciences and the Department of Food Science would place the University, College, and Department of Food Science in a strong position to impact these increasingly important international issues of acute and chronic diseases.

The Department of Food Science has a long history of international work involving both faculty and students. Approximately 40% of our graduate students and many of our visiting scholars have consistently been from other countries, which has enhanced our interactions with many institutions around the world. As a result, we currently have Memoranda of Understanding for collaborations with academic institutions in France, Italy, Ethiopia, and Thailand. Some additional specific examples of our international interactions are listed below.

Due to leadership provided by Dr. Audrey Maretzki, Emeritus Professor of Food Science, and funding provided by the Center for Higher Education of the United States Agency for International Development (USAID), the Pennsylvania State University and Tuskegee University collaborated with the University of Nairobi in establishing women’s NutriBusiness Cooperatives in the Rift Valley and Central Provinces of Kenya. Between 1992 and 1999, the cooperatives were established, facilities and equipment were supplied, and extensive participatory training was provided by university-affiliated
investigators and project staff. This initiative enabled approximately 2500 rural Kenyan women farmers to add value to their crops by processing and locally marketing nutritious, convenient, culturally-appropriate weaning food mixes.

Our Department frequently hosts interns and visiting scientists from around the world. The Department of Food Science has hosted several Borlaug Fellows from East, West, and South Africa, as well as Egypt, since 2009. In 2013 and through the “Feed the Future Program,” a global hunger and food security initiative, Dr. Catherine Cutter, Dr. Gregory Ziegler, and Dr. Kerry Kaylegian hosted 10 Borlaug Fellows. This particular Borlaug Program supports fellows’ efforts to address the root causes of hunger and poverty and forge long-term solutions to chronic food insecurity and malnutrition. Dr. Aubrey Maretzki hosted an International Seminar Series on Indigenous Knowledge Issues in our Department which attracted many International speakers.

The Department of Food Science currently offers three study-abroad courses which are open to both undergraduate and graduate students. Dr. Daniel Azzara, Alan R. Warehime Professor of Agribusiness and Food Science, offers AG BM 470: Comparing Agricultural and Food Systems in the United States and France. Dr. Ryan Elias, Associate Professor of Food Science, offers FD SC 499A: Food Systems in Italy. This course examines European food production norms through the lens of northern Italy. Dr. Ramaswamy Anantheswaran, Professor of Food Science, offers FD SC 499: Global Perspectives on Agriculture & Food Systems in India. This course explores food production, distribution, and processing operations in India, while helping students learn about the role agriculture is playing in the booming economy of India.

Food Science is a separate graduate program in our College and is based on five disciplines: food chemistry, food microbiology, food engineering, sensory science, and human nutrition. However, in actuality the concept of food is connected to numerous other majors within our College and various critical issues around the world, such as ecology, land-use, renewable resources, water quality and use, sewage treatment, etc. Traditionally the graduate curriculum in Food Science has been limited to the five disciplines in food science, and thus did not promote a more broad and multi-issue approach to a graduate degree in Food Science. The proposed dual-title degree in Food Science and INTAD will better prepare our graduate students to integrate their skills in food science with other skills required to address the increasingly complex global problems related to food, agriculture, and human populations.

The courses that can be used to satisfy the INTAD degree requirements as electives are:

- ADTED/CIED 508: Globalization and Lifelong Learning (3)
- ADTED/CIED 509: Language, Literacy, Identity, and Culture in a Global Context (3)
- AEREC 550: International Economic Development and Agriculture (3)
- AGBIO/FDSC 521: Food Defense: Prevention Planning for Food Processors (3)
- AGECO/ENT/CSIED 457: Principles of Integrated Pest Management (3)
- AYFCE 438: Living in an Increasingly Diverse Society (3)
- AYFCE 550: Program Development and Evaluation in Youth, Families, and Communities (3)
- AYFCE 555: Volunteer Program Management (3)
- AYFCE 845: Intergenerational Programs and Practices (3)
- BIOL 415: Ecotoxicology (3)
- CED 410: The Global Seminar (3)
- CED 417: Power, Conflict, and Community Decision Making (3)
- CED 425: International Community and Economic Development (3)
- CIED 553: Educational Mobility in Comparative Perspective (3)
- ENT 530: Seminar in Insect Science (1)
- FOR 418: Agroforestry: Science, Design, and Practice (3)
- FOR 488: Global Forest Conservation (3)
- GEOG 430: Human Use of the Environment (3)
- GEOG 439: Property and the Global Environment (3)
- GEOG 444: African Resources & Development (3)
- INTAG 481: Problems in Agriculture in Tropical Areas (3)
- PPEM 405: Microbe-Plant Interactions: Plant Disease and Biological Control
- PPEM 454: Virus Ecology (3)
- R SOC 508: Sociology of Agriculture (3)
- R SOC 525: Fertility, Population Change & Development (3)
- R SOC 555: Human Dimensions of National Resources (3)
- SOILS 502: Soil Properties and Functions (3)
Revised Bulletin Copy – Additions highlighted

Food Science (FD SC)

Program Home Page

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202 Rodney A. Erickson Food Science Building
814-865-5444
foodsci@psu.edu

Degrees Conferred:

Ph.D., M.S.
Dual-Title Ph.D. in Food Science and Clinical Translational Research
Dual-Title M.S. in Food Science and International Agriculture and Development
Dual-Title Ph.D. in Food Science and International Agriculture and Development

The Graduate Faculty in Food Science

- Ramaswamy C. Anantheswaran, Ph.D. (CORNELL UNIVERSITY), Professor of Food Science
- Jonathan Campbell, Ph.D. (IOWA STATE UNIVERSITY OF SCIENCE AND TEC), Assistant Professor of Animal Science and Food Science
- John Neil Coupland, Ph.D. (UNIVERSITY OF LEEDS), Professor of Food Science
- Catherine Cutter, Ph.D. (CLEMSON UNIVERSITY), Professor of Food Science
- Stephanie Doores, Ph.D. (UNIVERSITY OF MARYLAND COLLEGE PARK), Associate Professor of Food Science
- Edward G. Dudley, Ph.D. (UNIVERSITY OF WISCONSIN-MADISON), Associate Professor of Food Science
- Ryan J Elias, Ph.D. (UNIVERSITY OF MASSACHUSETTS IN AMHERST), Associate Professor of Food Science
- Hassan Gourama, Ph.D. (UNIVERSITY OF NEBRASKA, LINCOLN), Associate Professor of Food Science
- Federico Harte, Ph.D. (WASHINGTON STATE UNIVERSITY), Associate Professor of Food Science
- John Hayes, Ph.D. (UNIVERSITY OF CONNECTICUT), Associate Professor of Food Science
- Kerry Kaylegian, Ph.D. (CORNELL UNIVERSITY), Dairy Foods Research and Extension Associate
- Kathleen Keller, Ph.D. (RUTGERS, STATE UNIVERSITY OF NEW JERSEY), Assistant Professor of Nutritional Sciences and Food Science
- Stephen J. Knabel, Ph.D. (IOWA STATE UNIVERSITY OF SCIENCE AND TEC), Professor of Food Science
- Luke La Borde, Ph.D. (UNIVERSITY OF WISCONSIN-MADISON), Associate Professor of Food Science
- Joshua D Lambert, Ph.D. (UNIVERSITY OF ARIZONA), Associate Professor of Food Science
- Sara Milillo, Ph.D. (CORNELL UNIVERSITY), Instructor
- Robert F. Roberts, Ph.D. (UNIVERSITY OF MINNESOTA MINNEAPOLIS), Professor of Food Science
- Jairam Vanamala, Ph.D. (TEXAS A & M UNIVERSITY), Associate Professor of Food Science
- Gregory R. Ziegler, Ph.D. (CORNELL UNIVERSITY), Professor of Food Science

The Programs

Graduate work leading to the M.S. and Ph.D. degrees in Food Science is directed toward a multidisciplinary and integrated approach to teaching and research relevant to processing and
manufacture of value-added foods from agricultural commodities. Through integration of the disciplines of chemistry, microbiology, engineering, and nutrition, students learn to ensure that consumers can make healthful choices from an abundant supply of affordable, safe, nutritious, and appealing foods.

**Admission Requirements**

Requirements listed here are in addition to requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin. Applicants apply for admission to the program via the Graduate School application for admission.

Scores from the Graduate Record Examinations (GRE) are required for admission.

Students with a 3.00 junior/senior average (on a 4.00 scale) will be considered for admission to the program. Exceptions may be made at the discretion of the program for students.

Best preparation for graduate work would be the completion of an undergraduate degree in food science, biochemistry, microbiology, or other related areas. The undergraduate program must include calculus, organic chemistry, microbiology, and general physics. Students may be provisionally admitted with deficiencies but are required to make them up without degree credit.

Students are generally admitted directly to a master's program unless they have previously earned an M.S. degree in food science or an appropriate related area; in such cases, admission can be made directly to the doctoral program by approval of the graduate program committee.

**Master's Degree Requirements**

Requirements listed here are in addition to requirements stated in the DEGREE REQUIREMENTS section of the Graduate Bulletin.

A minimum of 30 credits at the 400, 500, 600 or 800 level is required, with at least 18 credits in the 500 and 600 series, combined. There are 24 credits required in the following core courses:

- Fundamentals of Food Science (FD SC 500A, FD SC 500B, FD SC 500C, and FD SC 500D), 4 credits;
- Research Methods in Food Science (FD SC 501), 2 credits;
- Other 500-level FD SC courses, 6 credits (3 credits of the requirement can be satisfied by 400 level Food Science courses with permission of the adviser.)
- Additional 400 or 500-level courses, 6 credits
  - Must include-Statistics (STAT 500 Applied Statistics or equivalent)
- Thesis Research (FD SC 600), 6 credits.

In addition, M.S. students are required to complete 1 credit of Supervised Experience in College Teaching (FD SC 602); however, this 1 credit cannot be counted towards the minimum 30
credits required. The remaining 6 elective credits may be chosen from a list of approved electives maintained by the program office.

The M.S. degree also requires the formation of a master's committee, the writing of a satisfactory thesis accepted by the master's committee, the head of the graduate program, and the Graduate School, and the passing of a final oral examination.

**Doctoral Degree Requirements**

Requirements listed here are in addition to requirements stated in the DEGREE REQUIREMENTS section of the Graduate Bulletin.

A minimum of 18 credits is required for the Ph.D. degree; Ph.D. students who did not complete the M.S. in Food Science at Penn State must complete 6 additional credits, for a minimum of 24 credits:

- Fundamentals of Food Science (FD SC 500A, FD SC 500B, FD SC 500C, and FD SC 500D), 4 credits (Not needed if student received credit for these courses during master's degree program at Penn State.
- Research Methods in Food Science (FD SC 501), 2 credits (Not needed if student received credit for this course during master's degree program at Penn State.)
- Other 500-level FD SC courses, 6 credits (3 credits of this requirement can be satisfied by 400-level Food Science courses with permission of the adviser.)
- Additional 400 or 500-level courses, 12 credits
- Additionally, students must have satisfactorily completed at least one 400 or 500-level course in statistics (i.e., STAT 500 Applied Statistics or equivalent), during their undergraduate or graduate program

In addition, Ph.D. students are required to complete 2 credits of Supervised Experience in College Teaching (FD SC 602); however, these 2 credits cannot be counted towards the minimum credits required for the degree.

Except in special cases, an M.S. in Food Science is earned before pursuing a Ph.D. degree. Although most applicants to the Ph.D. program have already obtained a master's degree in Food Science or a related program, the M.S. degree is not a prerequisite for entrance into the doctoral program. For students entering the Ph.D. program without having earned an M.S. degree in Food Science, there are two additional course requirements:

- Dissertation Research (FD SC 600), 6 credits
- Additional 400 or 500-level FD SC courses, 6 credits

All doctoral students must pass a candidacy examination, a comprehensive written and oral examination, and a final oral examination (the dissertation defense). To earn the Ph.D. degree, doctoral students must also write a dissertation that is accepted by the doctoral committee, the head of the graduate program, and the Graduate School. In addition, all Food Science Ph.D. candidates are assessed for English competency. International students who plan to be teaching
assistants must also take the American English Oral Communicative Proficiency Test (AEOCPT).

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

Students must apply and be admitted to the graduate program in Food Science 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 admissions requirements of the CTS dual-title program. Refer to the Admission Requirements section of the [CTS Bulletin page](#). Doctoral students must be admitted into the dual-title degree program in CTS prior to obtaining candidacy in their primary graduate program. An admissions committee comprised of faculty affiliated with the dual-title program will evaluate applicants. Applicants must have a graduate GPA of at least 3.5. Prospective dual-title program students must include in their application a statement of purpose that addresses the ways in which their research and professional goals will be enhanced by an interdisciplinary course of study in clinical and translational sciences.

The Dual-Title Ph.D. Degree in Food Science and Clinical and Translational Sciences emphasizes interdisciplinary scholarship at the interface of basic sciences, clinical sciences, and human health. Students in the dual-title program are required to have two advisers from separate disciplines: one individual serving as the primary mentor from the Graduate Program in Food Science and another individual serving as the secondary mentor from an area covered by the dual-title program who is a member of the Clinical and Translational Sciences faculty.

**Degree Requirements**

To qualify for the dual-title degree in Food Science and Clinical and Translational Sciences, students must satisfy the Food Science Ph.D. degree requirements listed in the “Doctoral Degree Requirements” section above. In addition, students must complete the degree requirements for the dual-title CTS, listed on the [CTS Bulletin page](#). Approximately 6 credits of course work may overlap with elective courses required by the Ph.D. Program in Food Science.

For students in the dual-title program, the candidacy examination consists of the standard Food Science candidacy exam with one modification. A member of the CTS Graduate Faculty will join the standing FD SC candidacy committee during the normal FD SC exam and assess the student’s CTS knowledge. Faculty members who hold appointments in both programs’ Graduate Faculty may serve in a combined role. This occurs by assigning the student a paper that has clinical relevance, or by asking the student questions that require him or her to extend the assigned paper into a clinical/translational context. This examination must be completed before the end of the second year, within four semesters (summer sessions do not count) of entry into the doctoral program.

The student’s doctoral committee will include Graduate Faculty from Food Science and Graduate Faculty from Clinical and Translational Science. In accordance with [Graduate Council policy](#), the doctoral committee of a Food Science and CTS dual-title doctoral degree student must include at least one member of the CTS Graduate Faculty. Faculty members who hold
appointments in both programs’ Graduate Faculty may serve in a combined role. If the chair of the doctoral committee representing Food Science 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 fields of food science and clinical and translational sciences will be integrated in the student’s comprehensive examination. The CTS representative on the student’s doctoral committee will develop questions for and participate in the evaluation of the comprehensive examination. All dual-title students are required to conduct dissertation research that contributes fundamentally to the fields of food science 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 doctoral committee, the head of the graduate program, and the Graduate School.

**Dual-Title Graduate Degree in Food Science and International Agriculture and Development (INTAD)**

Graduate students with research and educational interests in international education may apply to the dual-title degree program in Food Science and INTAD. The goal of the dual-title degree program in Food Science and INTAD is to enable graduate students from Food Science to acquire the knowledge and skills of their primary area of specialization in Food Science, while at the same time gaining the perspective and methods needed for work in international agriculture. Graduate study in this program seeks to prepare students to assume leadership roles in science, science education, outreach, and project management anywhere in the world. Students are required to write research proposals and expected to write grants to support their research activities, reflecting the dual-title degree. As part of their professional development presentations, publication of research articles and active participation in professional societies is expected. Emphasis is placed upon the professional development of the student. Students are able to specialize in the research program areas of food chemistry, food microbiology, food engineering, effects of processes on nutrition, sensory science, bioactive components, human gut microbiome, food processing, and Extension education. At the same time they will acquire a broad perspective about how to apply their research findings in the context of the broader international community. Thus, the dual-title will allow students to master their field of specialization from an international perspective so that they can compare practices and outcomes between countries and regions.

**Admission Requirements**

For admission to the dual-title graduate degree under this program, a student must first apply and be admitted to the Food Science graduate program and the Graduate School. Once accepted into the Food Science program, the student can then submit an application to the INTAD Academic Program Committee for admission to the dual-title degree program. The student must obtain consent from their Food Science adviser prior to applying to the INTAD program. Refer to the Admission Requirements section of the [INTAD Bulletin page](http://example.com). Ph.D. students must apply and be admitted to the dual-title degree program in International Agriculture and Development prior to taking the candidacy exam.
Degree Requirements for the Dual-Title M.S. in Food Science and INTAD

To qualify for this dual-title degree, students must satisfy the requirements of the Food Science Master of Science degree program, described above under “Master’s Degree Requirements.” In addition, they must satisfy INTAD program requirements for the dual-title master’s degree. Some courses may satisfy both Food Science program requirements and those of the INTAD program. Final course selection must be approved by the student’s advisory committee.

Degree Requirements for the Dual-Title Ph.D. in Food Science and INTAD

To qualify for this dual-title degree, students must satisfy the requirements of the Food Science Ph.D. program, described above under “Doctoral Degree Requirements.” In addition, they must satisfy INTAD program requirements for the dual-title Ph.D. degree. Some courses may satisfy both Food Science program requirements and those of the INTAD program. Final course selection must be approved by the student’s doctoral committee.

The Candidacy Examination committee for the dual-title degree will be composed of Graduate Faculty from Food Science and must include at least one Graduate Faculty member from the INTAD Program. Faculty members who hold appointments in both programs’ Graduate Faculty may serve in a combined role. There will be a single candidacy examination, containing elements of both Food Science and INTAD. Dual-title graduate degree students may require an additional semester to fulfill requirements for both areas of study and, therefore, the candidacy examination may be delayed one semester beyond the normal period allowable.

In addition to the general Graduate Council requirements for doctoral committees, the doctoral committee of a dual-title doctoral degree student must include at least one member of the INTAD Graduate Faculty. Faculty members who hold appointments in both programs’ Graduate Faculty may serve in a combined role. If the chair of the committee representing Food Science is not also a member of the Graduate Faculty in INTAD, the member of the committee representing INTAD must be appointed as co-chair. The INTAD representative on the student’s doctoral 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 reflects their original research and education in Food Science and INTAD. 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 doctoral committee, the head of the graduate program, and the Graduate School.
Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the Graduate Bulletin. Students on graduate assistantships must adhere to the course load limits set forth in the Graduate Bulletin.

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.

FOOD SCIENCE (FD SC) course list
International Agriculture and Development

MELANIE MILLER FOSTER, Assistant Professor
Office of International Programs, College of Agricultural Sciences
106 Agricultural Administration Building
814-867-3831; mjm727@psu.edu

EDWIN RAJOTTE, Co-Program Coordinator, Professor of Entomology
508 Agricultural Sciences and Industries Building
814-863-6461; egrajotte@psu.edu

LEIF JENSEN, Co-Program Coordinator, Distinguished Professor of Rural Sociology and Demography
101A Armsby Building
814-863-8642; ljensen@psu.edu

Degrees Conferred
Students electing this degree program through participating programs will earn a degree with a dual-title at the Master’s or Ph.D. level. Students receive a degree that lists their major program and International Agriculture and Development (INTAD).

The International Agriculture and Development (INTAD) program is offered through the following graduate programs: Agricultural and Extension Education (AEE), Agricultural Environmental, and Regional Economics (AEREC), Entomology (ENT), Food Science (FD SC), Plant Pathology (PPATH), Rural Sociology (R SOC), and Soil Science (SOILS). The dual-title degree enables qualified students from the College of Agricultural Sciences and other select programs at Penn State to combine their major degree with an internationally focused program of study to gain global competency skills and techniques for application of their discipline in a global environment.

The Graduate Faculty

The Program
The INTAD dual-title graduate degree program is administered by the INTAD - Academic Program Management Committee. The committee maintains the curriculum, identifies courses appropriate for the program, and develops and recommends policy and procedures for the program’s operation to the dean of the College of Agricultural Sciences and the dean of the Graduate School. Faculty members of the INTAD graduate program also serve on master’s and doctoral committees for students who are accepted into the dual-title program. This dual-title program enables students to learn about international agriculture while maintaining a close association with their primary area of interest in their home department.
Admission Requirements
To pursue the INTAD dual-title offering, a student must first apply to and be admitted to one of the participating graduate degree programs and the Graduate School at Penn State. Upon acceptance into the major program, the student can apply to the INTAD dual-title program. The student will submit an application to the INTAD Academic Program Committee. The application will include a written personal statement indicating the career goals they hope to accomplish by earning a dual-title degree. Graduates of the dual-title INTAD master's degree program who wish to pursue an INTAD doctoral degree must re-apply to the INTAD program for admission. Ph.D. students must apply and be admitted to the dual-title degree program in International Agriculture and Development prior to taking the candidacy exam.

Master's Degree Requirements
To qualify for the INTAD dual-title degree, students must satisfy the requirements of the graduate program in which they are enrolled. In addition, they must satisfy the minimum requirements of the INTAD dual-title degree specified here.

Course Requirements
Students are required to complete a minimum of 12 INTAD course credits (400, 500, or 800) for a dual-title master’s degree. 9 credits will be from the core curriculum: INTAD 820 International Agricultural Development Seminar (3), AEE 450 Program Design and Delivery (3), and CEDEV/AEE 505 Leadership Development (3). The remaining three credits must be taken as an internationally focused independent study, research, teaching, or internship.

Final course selection is determined by the students, their major program advisers, and their INTAD advisers. These advisers will discuss with the student a program of study that meets the student’s career goals and is in accord with the policies of the Graduate Council and the INTAD dual-title program. Some courses may satisfy both the major graduate program requirements and those of the INTAD dual-title program. Permission from a student’s academic adviser, in consultation with the program chair, is required to substitute a 400-level course for a 500-level course; however, the Graduate Council requirement for 18 credits at the 500 and 600 level combined must still be met, in total, across both the major and the dual-title courses of study.

Thesis
Students pursuing a Master of Science (M.S.) degree that requires a master’s thesis, in addition to the 12 credits specified above, must write the thesis on a topic that reflects both the graduate program in their primary degree and the dual-title offering in INTAD. At least 6 credits in thesis research (SUBJ 600 or 610) must be taken in the major program.

All members of the student’s committee for the dual-title master’s degree will be members of the Graduate Faculty. The committee must include at least one Graduate Faculty member from INTAD. A Degree Committee form should be filed upon selection of the committee members and should be approved by the INTAD Academic Program Committee Co-chair.
Ph.D. Degree Requirements

To qualify for the INTAD dual-title degree, students must satisfy the requirements of the graduate program in which they are enrolled. In addition, they must satisfy the minimum requirements of the INTAD dual-title degree specified here.

Students admitted to the doctoral INTAD dual-title offering must exhibit high research competence, including ability to identify, conceptualize, and execute a significant research project that makes a significant addition to the body of knowledge in the field. Students also should be fluent in reading, writing, and speaking English.

Course Requirements

Students are required to complete a minimum of 18 INTAD credits for a dual-title Ph.D. degree. The 18 required credits must be at the 500- or 800-level. 9 credits will be from the core curriculum: INTAD 820 International Agricultural Development Seminar (3), R SOC 517 International Rural Social Change (3), and either R SOC 508 Sociology of Agriculture (3) or R SOC 555 Human Dimensions of Natural Resources (3). 6 credits must be from INTAD electives. A list of approved elective courses is maintained by the graduate program office. The remaining 3 credits must be taken as an internationally focused independent study, research, teaching, or internship. In addition, they will be encouraged to pursue proficiency in a language other than English, as appropriate.

INTAD master’s degree credits may be carried over to the doctoral program. 6 additional INTAD credits will be required. INTAD master’s degree graduates who pursue an INTAD Ph.D. are required to take the INTAD 820 International Agricultural Development Seminar a second time, for an additional 3 credits.

Final course selection is determined by the student and the doctoral committee. The doctoral committee will discuss with the student a program of study that meets the student’s career goals and is in accord with the policies of the Graduate Council and the INTAD dual-title program. Some courses may satisfy both the major graduate program requirements and those of the INTAD dual-title program. Permission from a student’s doctoral committee, in consultation with the program chair, is required to substitute a 400-level course for a 500-level course.

Candidacy

Candidacy procedures will be based on the procedures of the major program and will have an international dimension. There will be a single candidacy examination, assessing candidacy for both the primary program and INTAD. The candidacy committee must include at least one member of the INTAD Graduate Faculty. Faculty members who hold appointments in both programs’ Graduate Faculty may serve in a combined role. Although not encouraged, the dual-title degree student may require an additional semester to fulfill requirements for the dual-title degree program. Therefore, under exceptional circumstances, the candidacy exam may be delayed for one semester at the discretion of the student's adviser in consultation with the INTAD program coordinators.
**Doctoral Committee Composition**

In addition to the [general Graduate Council requirements for doctoral committees](#), the doctoral committee of a Ph.D. dual-title degree student in INTAD must include at least one representative from the INTAD Graduate Faculty. Faculty members who hold appointments in both programs’ Graduate Faculty may serve in a combined role. If the chair is not an INTAD Graduate Faculty member, the member of the committee representing INTAD must be appointed co-chair of the committee.

**Comprehensive Exam**

At the end of their course work, students must complete a comprehensive examination that follows the guidelines established by the primary program and reflects both their primary program and the dual-title degree curriculum. International agriculture must be one of the key areas of the exam and the INTAD representative on the student’s doctoral committee must have input into the development of and participate in the evaluation of the comprehensive evaluation.

**Dissertation and Dissertation Defense**

Upon completion of the doctoral dissertation, the candidate must pass a final oral examination (the dissertation defense) to earn the Ph.D. degree. Doctoral students enrolled in the dual-title degree program are required to write and orally defend a dissertation on a topic that reflects their original research and education in both their primary program and the INTAD dual-title program. The dissertation must be accepted by the doctoral committee, the head of the graduate program, and the Graduate School.

**Student Aid**

Graduate assistantships available to students in this program and other forms of student aid are described in the [Student Aid](#) section of the [Graduate Bulletin](#). Students on graduate assistantships must adhere to the [course load limits set forth in the Graduate Bulletin](#). A limited number of Research Assistantships are also available through the College of Agricultural Sciences.

**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.
CONSULTATION

The Food Science Department faculty have been consulted and are supportive of this dual-title degree program. The Academic Program Committee, representing the current participating graduate programs in INTAD, was consulted and is supportive of the Food Science graduate program joining the INTAD dual-title.
Graduate Council
Program, Option, or Minor Proposal Form

Submit 1 original, signed Graduate Council proposal form and 2 hardcopies of the graduate program proposal document, with a copy of the signed proposal form attached to each proposal copy, to the Office of the Dean of the Graduate School, 211 Kern Building, University Park. For more information about the process, see the Overview of the Graduate Council Curricular Review Process.

The Proposal Proposal Procedures provide guidance for the development of a graduate program proposal. If you have questions regarding the preparation of a graduate program proposal or how to complete this Graduate Council proposal form, contact the Office of the Dean of the Graduate School.

College/School: Penn State Harrisburg
Department or Instructional Area: School of Business Administration

New Graduate Program, Option, or Minor: Add

Designation of new graduate program:

Classification of Instructional Programs (CIP) Code:

Designation of new graduate option:

Designation of new graduate minor:

Indicate effective semester:

First semester following approval
Second semester following approval

Existing Graduate Program Option, or Minor [ ] Change [ ] Drop

Current designation of graduate program:

Current designation of graduate option:

Current designation of graduate minor:

New designation of existing graduate program (if changing): B.S. in Information Systems and MSIS IUG Degree Program

New designation of existing graduate option (if changing):

New designation of existing graduate minor (if changing):

Brief description of the change (if not noted above):

Indicate effective semester:

[ ] First semester following approval
[ ] Second semester following approval

Submitted by Graduate Program Head

Dr. Stephen Schappe
Printed name
Signature
Date: 12/6/14

Noted By College/School Representative to Graduate Council Subcommittee on New and Revised Programs and Courses:

Dr. Janet Duck
Printed name
Signature
Date: 12/12/14

Approved by College/School Dean/Chancellor (or Designee):

Dr. Peter Idowu
Printed name
Signature
Date: Dec 12, 2016
Recommended by Chair, Graduate Council Subcommittee on New and Revised Programs and Courses:

On Behalf of John Challis
Printed name
Signature
Date: 3/7/2017

Recommended by Chair, Graduate Council Committee on Programs and Courses:

On Behalf of M. Kathleen Heid
Printed name
Signature
Date: 3/7/2017

Noted by Dean of the Graduate School:

On Behalf of Regina Vasilatos-Younken
Printed name
Signature
Date: 3/7/2017
Bachelor of Science in Information Systems and Master of Science in Information Systems

Integrated Undergraduate-Graduate (IUG)

Degree Program Proposal

School of Business Administration

Penn State Harrisburg

October 19, 2016
Executive Summary

A. Objectives of the Proposed IUG Program
The objectives of the Integrated Undergraduate Graduate Program are to:
1. Offer qualified students the opportunity to earn both bachelor and master degrees in five years. In particular, IUG students may count up to 12 credits toward their B.S. in Information Systems and M.S.I.S. degree requirements.
2. Permit coherent planning of studies through the graduate degree, with advising informed by not only the requirements of the baccalaureate program, but also the longer-range goals of the graduate degree.
3. Introduce students earlier to the rigors of the graduate program and research of graduate faculty.
4. Make the resources of the Graduate School available to IUG students.
5. Allow students with IUG status to benefit from their association with graduate students whose level of work and whose intensity of interest and commitment parallel their own.
6. Allow students to coordinate as well as concurrently pursue the two degree programs, which enables them to achieve greater depth and comprehension than if the degrees are pursued sequentially.

B. Summary of Changes
1. Undergraduate Bulletin description of Information Systems program is revised to include the proposed IUG program.
2. Graduate Bulletin description of M.S.I.S. program is revised to include the proposed IUG program.
3. No course changes are part of this proposal.
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B.S. in Information Systems and M.S.I.S.
Integrated Undergraduate-Graduate (IUG)
Degree Program Proposal
School of Business Administration
Penn State Harrisburg

I. Introduction
The School of Business Administration offers a limited number of academically superior Bachelor of Science in Information Systems candidates the opportunity to enroll in an integrated, continuous program of study leading to both the Bachelor of Science in Information Systems and the Master of Science in Information Systems. The ability to coordinate as well as concurrently pursue the two degree programs enables the students to earn both degrees in five years. Specifically, as many as twelve of the credits required for the master’s degree may be applied to both undergraduate and graduate degree programs. The Integrated Undergraduate-Graduate Program reduces the total number of credits needed to earn both degrees from 150 to 138.

II. Application Process
To initiate the application process, students must submit a resume, a personal statement including career goals and how M.S.I.S will enhance their career goals, official transcripts of all post-secondary courses taken outside Penn State, two letters of recommendation, with at least one from the School of Business Administration faculty, and a plan of study that integrates both undergraduate and graduate requirements. A graduate faculty adviser in collaboration with the Director of M.S.I.S. Program will help undergraduate candidates determine a sequence of courses that will prepare them for acceptance into the Integrated Undergraduate-Graduate (IUG) degree program.

Admission Requirements
The number of openings in the IUG program is limited. Applicants to the IUG program must have:
1. Completed a minimum of 60 credits. Students must be admitted to an IUG program no earlier than the beginning of the third semester of undergraduate study at Penn State (regardless of transfer or AP credits accumulated prior to enrollment) and no later than the end of the second week of the semester preceding the semester of expected conferral of the undergraduate degree.
2. Earned a minimum of cumulative grade point average of 3.5.
3. Completed the following Entry to Major courses or equivalent:
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>ECON 102</td>
<td>Introductory Microeconomic Analysis and Policy</td>
</tr>
<tr>
<td>ENGL 015 or 030</td>
<td>Rhetoric and Composition or Honors Freshmen Composition</td>
</tr>
<tr>
<td>FIN 301</td>
<td>Corporation Finance</td>
</tr>
<tr>
<td>MATH 110 or 140</td>
<td>Techniques of Calculus I or Calculus with Analytic Geometry I</td>
</tr>
<tr>
<td>MGMT 301</td>
<td>Basic Management Concepts</td>
</tr>
<tr>
<td>MKTG 301</td>
<td>Principles of Marketing</td>
</tr>
<tr>
<td>STAT 200 or SCM 200</td>
<td>Elementary Statistics or Introduction to Statistics for Business</td>
</tr>
</tbody>
</table>

To formally apply, students must submit a completed Graduate School application for admission. The students should mention in the notes section that the application is for the IUG program in Information Systems. The Graduate Management Admission Test (GMAT) or Graduate Record Examination (GRE) is not required for admission into the program; however, if students are interested in applying for a graduate assistantship, GMAT or GRE scores must be submitted by the end of the eighth semester.

Student applications will be evaluated based on their overall portfolio, in addition to the above requirements. In all cases, admission to the program will be at the discretion of the Graduate Admissions Committee in Information Systems.

**Reduced Course Load**

As many as twelve of the credits required for the master’s degree may be applied to both undergraduate and graduate degree programs. All courses proposed to count for both degrees must be at the 500- or 800-level. Below shows a sample sequence of coursework for the third, fourth and fifth year.
Semester V

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>B A 241</td>
<td>Legal Environment of Business</td>
<td>2</td>
</tr>
<tr>
<td>B A 242</td>
<td>Social and Ethical of Business</td>
<td>2</td>
</tr>
<tr>
<td>ECON 104</td>
<td>Introductory Macroeconomics Analysis</td>
<td>3</td>
</tr>
<tr>
<td>MIS 307</td>
<td>Algorithmic Concepts</td>
<td>3</td>
</tr>
<tr>
<td>MIS 465</td>
<td>Database Management</td>
<td>3</td>
</tr>
<tr>
<td>Non-Business elective</td>
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<td>3</td>
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<tr>
<td>Health and Physical Activity GHA</td>
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Semester VI

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<td>3</td>
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<tr>
<td>MIS 448</td>
<td>Business Telecommunications</td>
<td>3</td>
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<td>Sciences GN</td>
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<td>Arts GA</td>
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Semester VII

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<tr>
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<td>International Business and Society US; IL</td>
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<tr>
<td>Business support</td>
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<td>INFSY 540*</td>
<td>IT and Knowledge Mgmt</td>
<td>3</td>
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<tr>
<td>INFSY 535*</td>
<td>Object-oriented Design</td>
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Semester VIII

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<td>Business Strategy</td>
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<td>MIS 450</td>
<td>Systems Design Project</td>
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<tr>
<td>500 level INFSY elective*</td>
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Semester IX

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<tr>
<td>500 level INFSY Elective</td>
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<td>3</td>
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<tr>
<td>500-level Business Elective</td>
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Semester X

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<tr>
<td>INFSY 554</td>
<td>Master’s Project</td>
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</tr>
<tr>
<td>500 level INFSY Elective</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>500-level Business Elective</td>
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<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>9</strong></td>
</tr>
</tbody>
</table>

*Satisfies requirements for both the undergraduate and graduate programs for a total of 12 credits.

Eligibility for a Graduate Assistantship

Students in the IUG program will be eligible for consideration for a graduate assistantship to be awarded beginning of the fifth year. To be eligible for a graduate assistantship, students must have completed the requirements for their B.S. in Information Systems degree. The GMAT or GRE scores must be submitted by the end of the eighth semester to be considered for the assistantship.

III. IUG Degree Requirements

Students in the IUG program must satisfy the requirements for both the Bachelor of Science in Information Systems and Master of Science in Information Systems degrees, as listed in Appendix A and Appendix C. As outlined in the Reduced Course Load section above, the total course load is reduced due to courses that can count towards both degrees. The first two years of the IUG program are identical to the first two years of the Bachelor of Science program, listed in Appendix B. Students in the IUG program take five additional credits in their third year, and five fewer credits in their fourth year. The courses that count toward the Master of Science in Information Systems degree requirements are included in the fourth year.
Student performance will be monitored on an on-going basis. In addition, a formal evaluation of student academic performance will be performed when the students have completed 100 to 105 credits, which is at the end of the first semester of the senior year for typical students in the program. Students who have not maintained a 3.0 GPA in their graduate courses will be put on probationary status with respect to the IUG program. They will receive a warning letter regarding probationary status. Their ability to continue in the IUG program will be based on their academic performance in the last semester of their senior year.

If for any reason students admitted to the IUG program are unable to complete the requirements for the Master of Science in Information Systems degree, the students will be permitted to receive the Bachelor of Science in Information Systems degree assuming all the undergraduate degree requirements have been satisfactorily completed. If the students successfully complete courses listed in the recommended schedule, they will satisfy the requirements for the Bachelor of Science degree by the end of their fourth year.
Appendix A: Bachelor of Science in Information Systems Degree Requirements

General Education Requirements (47 credits)

- Writing/Speaking (GWS)
  ENGL 015S or 030 [3]  Rhetoric and Composition or Honors Freshmen Composition
  CAS 100 [3]  Effective Speech

- Quantitative (GQ)
  MATH 110 or 140 [4]  Techniques of Calculus I or Calculus with Analytic Geometry I
  STAT 200 or SCM 200 [4]  Elementary Statistics or Introduction to Statistics for Business

- Natural Sciences (GN)
  9 credits of any courses with a GN suffix

- Arts (GA)
  6 credits of any courses with a GA suffix

- Humanities (GH)
  6 credits of any courses with a GH suffix

- Social & Behavioral Sciences (GS)
  ECON 102 [3]  Introductory Microeconomic Analysis and Policy
  3 credits of any courses with a GS suffix

- Health & Physical Activities (GHA)
  3 credits of any courses with a GHA suffix

\[a\]Entry to Major requirements
\[b\]Students may apply 9-6-3 rule.

General Electives (8 credits)

8 credits of non-business courses
Major Requirements (79 credits, including 3 credits of GWS courses, 6 credits of GQ courses and 3 credits of GS courses)

- Prescribed Courses (49 credits)
  - Business Courses (37 credits)
    - ACCTG 211 [4] Financial and Managerial Accounting for Decision Making^a
    - B A 364Y [3; US/IL] International Business and Society
    - ECON 102 [3; GS] Introductory Microeconomic Analysis and Policy^a
    - ECON 104 [3] Introductory Macroeconomic Analysis and Policy
    - ENGL 202D [3; GWS] Effective Writing: Business Writing
    - FIN 301 [3] Corporation Finance^a
    - MIS 204 [3] Introductory to Business Information Systems
    - MKTG 301 [3] Principles of Marketing^a
    - SCM 301 [3] Supply Chain Management
  - Information Systems Courses (12 credits)
    - MIS 448 [3] Business Data Communications

- Additional Courses (24 credits)
  - Math, Statistics and Law (12 credits)
    - Select 3 credits from CMPSC 101 [4; GQ] or CMPSC 121 [4; GQ] or IST 140 [3]
    - CMPSC 101 [4] Introduction to C++ Programming
    - CMPSC 121 [4] Introduction to Programming Techniques
    - IST 140 [3] Introduction to Application Development
    - Select 4 credits from MATH 110 [4; GQ] or MATH 140 [4; GQ]^a
    - Select 4 credits from SCM 200 [4; GQ] or STAT 200 [4; GQ]^a
    - B A 243 [4] Social, Legal, and Ethical Environment for Business
  - Information Systems Electives (9 credits)
    - Select 9 credits from one of the following three areas of concentration A, B, or C:
      A. Application Development Concentration
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIS 413</td>
<td>Interface Design for Information Systems</td>
</tr>
<tr>
<td></td>
<td>Applications</td>
</tr>
<tr>
<td>MIS 466</td>
<td>Business Programming for the WEB</td>
</tr>
<tr>
<td>MIS 489</td>
<td>Seminar in Information Systems</td>
</tr>
</tbody>
</table>

B. Network Security Concentration
- MIS 489 [3] Seminar in Information Systems

C. Individualized Concentration
- MIS 413 [3] Interface Design for Information Systems
  Applications
- MIS 446 [3] Information Technology and Business Strategy
- MIS 489 [3] Seminar in Information Systems

- Supporting Courses and Related Areas (9 credits)
  Select 9 credits from 200-400 level business courses from: ACCTG, B A, ECON, FIN, MGMT, MIS, MKTG, or SCM in consultation with an academic adviser and in support of the student’s interests.

**Additional Requirements**
- First-Year Seminar, 1 credit of any course with an S, T, X or PSU designation.
- United States Cultures and International Cultures requirements: 3 credits of any course with a US designation and 3 credits of any course with an IL designation. These are satisfied simultaneously with any of the above requirements.
- Writing across the Curriculum requirement is satisfied by B A 364Y, a prescribed course.
- No more than 60 credits should be from business and business-related courses.
## Appendix B: Bachelor of Science in Information Systems Typical Schedule

<table>
<thead>
<tr>
<th>Semester I</th>
<th>Semester II</th>
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<tbody>
<tr>
<td><strong>ENGL 015 or 030 Composition GWS</strong></td>
<td><strong>CAS 100 Effective Speech GWS</strong></td>
</tr>
<tr>
<td><strong>MATH 110 or 140 Calculus GQ</strong></td>
<td>*<strong>STAT 200 or SCM 200 Statistics GQ</strong></td>
</tr>
<tr>
<td>Humanities GH</td>
<td>*<strong>MGMT 301 Basic Management concepts</strong></td>
</tr>
<tr>
<td><strong>ECON 102 Introductory Microeconomic Analysis GS</strong></td>
<td>Arts GA</td>
</tr>
<tr>
<td>Health and Physical Activity GHA</td>
<td>Sciences GN</td>
</tr>
<tr>
<td><strong>14.5</strong></td>
<td><strong>16</strong></td>
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<table>
<thead>
<tr>
<th>Semester III</th>
<th>Semester IV</th>
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</thead>
<tbody>
<tr>
<td><strong>ACCTG 211 Financial and Managerial Accounting</strong></td>
<td><strong>FIN 301 Corporation Finance</strong></td>
</tr>
<tr>
<td><strong>MKTG 301 Principles of Marketing</strong></td>
<td>IST 140 or CMPSC 101 or CMPSC 121</td>
</tr>
<tr>
<td><strong>MIS 204 Introduction of Business Information Systems</strong></td>
<td>Introduction to Programming GQ</td>
</tr>
<tr>
<td>Humanities GH</td>
<td><strong>ENGL 202D Business Writing</strong></td>
</tr>
<tr>
<td>Social and Behavioral Sciences GS</td>
<td>Sciences GN</td>
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<td><strong>16</strong></td>
<td><strong>15</strong></td>
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<table>
<thead>
<tr>
<th>Semester V</th>
<th>Semester VI</th>
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<tbody>
<tr>
<td>B A 241 Legal Environment of Business</td>
<td>SCM 301 Supply Chain Management</td>
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<tr>
<td>B A 242 Social and Ethical of Business</td>
<td><strong>Information Systems elective</strong></td>
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<tr>
<td>ECON 104 Introductory Macroeconomics Analysis</td>
<td>MIS 448 Business Telecommunications</td>
</tr>
<tr>
<td><strong>MIS 307 Algorithmic Concepts</strong></td>
<td>Sciences GN</td>
</tr>
<tr>
<td><strong>MIS 465 Database Management</strong></td>
<td>Arts GA</td>
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<tr>
<td>Health and Physical Activity GHA</td>
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<tr>
<td><strong>14.5</strong></td>
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<table>
<thead>
<tr>
<th>Semester VII</th>
<th>Semester VIII</th>
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<td>B A 364Y International Business and Society US; IL</td>
<td>B A 462 Business Strategy</td>
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<td>MIS 450 System Design Project</td>
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<tr>
<td>Business support</td>
<td><strong>Information Systems elective</strong></td>
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<tr>
<td>Non-Business elective</td>
<td>Non-Business elective</td>
</tr>
<tr>
<td><strong>15</strong></td>
<td><strong>12</strong></td>
</tr>
</tbody>
</table>

**Bold type requires a grade of C or better.**

*aEntry to major requirement*

*bBusiness support – select from 200-400 level Business courses from: B A, FIN, MIS, MGMT, MKTG, SCM or ACCTG in consultation with an academic adviser and in support of the student’s interests*

*bInformation Systems elective – select from one of the following three areas of concentration A, B, or C:*

A. Application Development Concentration - IST 302 IT Project Management; IST 413 Interface Design for Information Systems Applications; IST 466 Business Programming for the WEB; MIS 489 Seminar in Information Systems


C. Individualized Concentration - IST 302 IT Project Management; IST 451 Network Security; IST 456 Information Security Management; MIS 413 Interface Design for Information Systems Applications; MIS 446 Information Technology and Business Strategy; MIS 461 Web Technologies; MIS 466 Business Programming for the WEB; MIS 489 Seminar in Information Systems
Appendix C: Master of Science in Information Systems Degree Requirements

The M.S.I.S. program requires, excluding pre-program requirements, 30 credits of course work at the graduate level (500-level or higher).

These are distributed over three groups of courses: Prescribed Courses, Additional Courses, and Electives.

M.S.I.S. Degree Program

Master of Science in Information Systems

Prescribed Courses
INFSY 535. Object-Oriented Design and Program Development (3)
INFSY 540. Information Technology and Knowledge Management (3)
INFSY 554. Master's Project (3)

Additional Courses (choose 15 credits)
INFSY 543. Electronic Commerce (3)
INFSY 587. Global Information Technology (3)
INFSY 547. Web Enabled Technologies (3)
INFSY 555. Data Management (3)
INFSY 556. Data Warehousing (3)
INFSY 560. Data Communications Systems and Networks (3)
INFSY 563. Network Security Management (3)
INFSY 565. Intelligent Systems (3)
INFSY 566. Data Mining and Knowledge Discovery (3)
INFSY 570. Software Engineering in the Analysis and Design of Information Systems (3)
INFSY 575. Seminar in Information Technology Management (3)
INFSY 590. Colloquium in Information Systems

Electives (6 credits)

Elective courses allow students to select additional elective courses of interest. Six credits of elective courses should be taken from 500-level courses offered by Penn State Harrisburg's School of Business Administration.
Appendix D: External Consultation

Consultation with College of IST

From: GIRISH SUBRAMANIAN <ghs2@psu.edu>
Date: Monday, April 4, 2016 at 11:17 AM
To: Mary Beth Rosson <mrosson@ist.psu.edu>, Andrew Sears <asears@ist.psu.edu>
Subject: Fwd: IUG proposals for business majors/MBA, and INFSY/MIS at Harrisburg

Dear Dean Sears,

Our School wants to provide opportunities to our outstanding undergraduate business students through IUGs. The IUGs include six undergraduate majors/MBA (of which one is MIS), and Information Systems/M.S.I.S.. We respectfully request your help for the external review. Attached please find the proposals for the MIS-MBA and MIS-M.S.I.S. IUG programs.

All proposals have similar admission requirements -- the number of seats is limited; candidates need to have 3.5 cumulative GPA and complete entry-to-major requirements. IUG students will count up to 12 credits of graduate courses toward their undergraduate degree.

If you have any questions, please feel free to let me know.

We appreciate your time and input.

Best regards,

Girish

Girish Subramanian,
Director, M.S.I.S. Program and Program Coordinator, undergraduate MIS program

From: Andrew Sears <asears@ist.psu.edu>
To: GIRISH SUBRAMANIAN <ghs2@psu.edu>, Mary Beth Rosson <mrosson@ist.psu.edu>
Cc: Andrew Sears <asears@ist.psu.edu>
Subject: Re: IUG proposals for business majors/MBA, and INFSY/MIS at Harrisburg

Girish,

Thank you for sharing your proposal. After reviewing your plans, IST is supportive of your effort.

Andrew

---
Andrew Sears
Dean and Professor
College of Information Sciences and Technology
and
Interim Chief Information Security Officer
Consultation with Black School of Business and the M.B.A. Program at Erie

From: "Greg Filbeck" <mgf11@psu.edu>
To: "Oranee Tawatnuntachai" <oxt4@psu.edu>
Sent: Monday, August 1, 2016 3:19:21 PM
Subject: RE: IUG proposals for business majors/MBA, ACCTG/MPACC and INFSY/MIS at Harrisburg

Oranee,

Thank you for your kind wishes.

Balaji did not share this information with me – but I am in total support of your initiatives. Looks like a great idea!

Greg

Dr. Greg Filbeck, CFA, FRM, CAIA, CIPM, PRM
Samuel P. Black III Professor of Finance and Risk Management
Interim Director, Black School of Business
Penn State Erie, the Behrend College
286 Burke
Erie, PA 16563

---------------------------------------

From: Oranee Tawatnuntachai [mailto:oxt4@psu.edu]
Sent: Monday, August 01, 2016 1:42 PM
To: MICHAEL FILBECK
Subject: Fwd: IUG proposals for business majors/MBA, ACCTG/MPACC and INFSY/MIS at Harrisburg

Dear Greg,

Hope your summer has been going well. I just learned that you have become the School Director. Congratulations! So excited to be working with you.

I'm not sure whether Balaji mentioned to you regarding our IUG proposals or not. We sent the proposals to him in early April, but haven't got his response. Pls. see the message below. Could you pls. review and
provide a statement of support for our proposals? We're ready to submit the proposals to the Academic Affairs Committee for review.

All proposals have similar admission requirements -- the number of seats is limited; candidates need to have 3.5 cumulative GPA and complete entry-to-major requirements. IUG students will count up to 12 credits of graduate courses toward their undergraduate degree.

If you have any questions, please do not hesitate to let me know.

Regards,
Oranee

P.S. We already heard back from Al that he supports the proposals.

---------------------------------------

From: "Oranee Tawatnuntachai" <oxt4@psu.edu>
To: "BALAJI RAJAGOPALAN" <bur14@psu.edu>
Sent: Friday, April 1, 2016 11:37:28 AM
Subject: IUG proposals for business majors/MBA, ACCTG/MPACC and INFSY/MIS at Harrisburg

Dear School Director Rajagopalan,

Our School wants to provide opportunities to our outstanding undergraduate business students through IUGs. The IUGs include six undergraduate majors/MBA, Accounting/MPACC, and Information Systems/MIS. We respectfully request your help for the external review. Attached please find the proposals.

All proposals have similar admission requirements -- the number of seats is limited; candidates need to have 3.5 cumulative GPA and complete entry-to-major requirements. IUG students will count up to 12 credits of graduate courses toward their undergraduate degree.

If you have any questions, please feel free to let me know.

We appreciate your time and input.

Best regards,
Oranee

Oranee Tawatnuntachai, Ph.D., CFA
Associate Professor of Finance
Director, MBA Program
Penn State Harrisburg
Middletown, PA 17057
Tel. 717-948-6151
Fax 717-948-6456
Consultation with the M.B.A. Program at Great Valley

From: "JAMES A NEMES" <jan16@psu.edu>
To: "Oranee Tawatnuntachai" <oxt4@psu.edu>
Cc: "Stephen Schappe" <sxs28@psu.edu>
Sent: Thursday, August 11, 2016 6:34:31 PM
Subject: RE: IUG proposals for business majors/MBA, ACCTG/MPACC and INFSY/MIS at Harrisburg

Oranee,

Thanks for the clarification. I have no objections. Good luck with the IUGs. I will be interested to hear how they work out as we might want to explore these with our MBA, working with Penn State Abington and Penn State Brandywine. Also, I apologize for the delay in getting back to you.

Jim

James A. Nemes, D.Sc.
Chancellor and Chief Academic Officer
Professor of Mechanical Engineering
School of Graduate Professional Studies
Penn State Great Valley
30 East Swedesford Road
Malvern, PA 19355-1443
Phone: 610-648-3335
Fax: 610-648-3377
jan16@psu.edu

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From: Oranee Tawatnuntachai [mailto:oxt4@psu.edu]
Sent: Monday, August 01, 2016 4:10 PM
To: JAMES A NEMES <jan16@psu.edu>
Cc: Stephen Schappe <sxs28@psu.edu>
Subject: Re: IUG proposals for business majors/MBA, ACCTG/MPACC and INFSY/MIS at Harrisburg

Jim,

Yes. our program is 30 credits at a minimum.

IUG students who get waived out of 18 foundation credits need additional 18 MBA credits (at the minimum). However, 12 credits double counted must be graduate-level courses. That is, IUG begin taking graduate courses during their senior year.

We expect majority of IUG students to be in this situation because we limit the number of seats and select only top students.
Regards,
Oranee

---------------------------------------

From: "JAMES A NEMES" <jan16@psu.edu>
To: "Oranee Tawatnuntachai" <oxt4@psu.edu>
Cc: "Stephen Schappe" <sxs28@psu.edu>
Sent: Monday, August 1, 2016 3:33:30 PM
Subject: RE: IUG proposals for business majors/MBA, ACCTG/MPACC and INFSY/MIS at Harrisburg

Oranee,

I believe the one comment/clarification I have applies to all of these. The Harrisburg MBA appears to vary from 30 to 48 credits depending on how many foundation courses are waived if I understand the program correctly. Am I right that with this IUG that a student could have all foundation courses waived in addition to having 12 credits count toward both the Bachelor’s and the MBA? Essentially picking up the MBA for an additional 18 credits? Would this be the common situation or would that be the exception?

Thanks,

Jim

James A. Nemes, D.Sc.
Chancellor and Chief Academic Officer
Professor of Mechanical Engineering
School of Graduate Professional Studies
Penn State Great Valley
30 East Swedesford Road
Malvern, PA 19355-1443
Phone: 610-648-3335
Fax: 610-648-3377
jan16@psu.edu

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From: Oranee Tawatnuntachai [mailto:oxt4@psu.edu]
Sent: Monday, August 01, 2016 11:52 AM
To: jan16@psu.edu
Cc: Stephen Schappe <sxs28@psu.edu>
Subject: Fwd: IUG proposals for business majors/MBA, ACCTG/MPACC and INFSY/MIS at Harrisburg

Dear Jim,
Hope your summer has been going well. We sent you the IUG proposals in April. We're ready to submit the proposals to the Academic Affairs Committee for review. Could you pls. provide a statement of support for our proposals?

If you have any questions, please do not hesitate to let me know.

Regards,

Oranee

From: "Oranee Tawatnuntachai" <oxt4@psu.edu>
To: "JAMES A NEMES" <jan16@psu.edu>
Cc: "Stephen Schappe" <sxs28@psu.edu>
Sent: Friday, April 1, 2016 11:46:05 AM
Subject: IUG proposals for business majors/MBA, ACCTG/MPACC and INFSY/MIS at Harrisburg

Dear Jim,

Our School wants to provide opportunities to our outstanding undergraduate business students through IUGs. The IUGs include six undergraduate majors/MBA, Accounting/MPACC, and Information Systems/MIS. We respectfully request your help for the external review. Attached please find the proposals.

All proposals have similar admission requirements -- the number of seats is limited; candidates need to have 3.5 cumulative GPA and complete entry-to-major requirements. IUG students will count up to 12 credits of graduate courses toward their undergraduate degree.

If you have any questions, please feel free to let me know.

We appreciate your time and input.

Best regards,

Oranee

Oranee Tawatnuntachai, Ph.D., CFA
Associate Professor of Finance
Director, MBA Program
Penn State Harrisburg
Middletown, PA 17057
Tel. 717-948-6151
Fax 717-948-6456
Consultation with Smeal College of Business and the M.B.A. Program at Smeal College of Business

From: "Brian Cameron" <bcameron@smeal.psu.edu>
To: "Oranee Tawatnuntachai" <oxt4@psu.edu>
Cc: "Jeff Sharp" <jeffsharp@psu.edu>, "Steven Huddart" <sjh11@email.psu.edu>, "Charles H. Whiteman" <cwhiteman@psu.edu>, "Russell Barton" <rrb2@psu.edu>
Sent: Monday, August 8, 2016 9:09:53 AM
Subject: IUG proposals for business majors/MBA, ACCTG/MPACC and INFSY/MIS at Harrisburg

Dear Oranee

I am responding on behalf of the Smeal College of Business. We support the IUG proposals overall and the only comments are below from Steve Huddart.

We wish you success with these new programs.

Best regards,

Brian

Brian H. Cameron | Associate Dean for Professional Graduate Programs | Smeal College of Business | The Pennsylvania State University | University Park, PA 16802 | Phone: 814-863-1460 | Email: bcameron@smeal.psu.edu

------------------------------------------------------------------------------------

Tom,

I have reviewed the proposal for a B.S. in Accounting and M PAC IUG degree program at Harrisburg.

The proposal is clear and detailed.

I endorse it and wish you success with this new program.

The IUG program in accounting at Smeal graduates about 125 students each year. The students in this program are hotly recruited by employers and nearly all have accepted an offer of full-time employment before graduation.

My only comments on your proposal are minor:

1) Because the total number of credits needed to earn both degrees is reduced from 150 to 138, it may be useful to explain how an IUG student will meet the 150-credit-hour requirement for licensure as a CPA.

2) In the Admission Requirements section, the proposal states that "A typical student would apply after completing between 60 and 90 credits, that is, after the fifth semester and before the end of the seventh semester." Should "fifth" be "fourth"?

3) The Accounting (ACNT)- Recommended Academic Plan on page 11 requires 121 credits. The academic plan for IUG students' semesters IX and X prescribes a further 18 credits. Does this mean that the total number of credits required to earn both degrees is 139, not 138?
4) I believe that one reason for the success of Smeal's accounting IUG is that most students in the program complete at least one internship. Provision is made for this student's academic plans. Is an internship encouraged and feasible within the proposed program?

Steven Huddart
Department Chair and Smeal Chair Professor in Accounting
Smeal College of Business
Penn State
354B Business Building
University Park, PA 16802-3603
(814) 865-0041

Begin forwarded message:

From: Jeff Sharp <jeffsharp@psu.edu>

Subject: FW: IUG proposals for business majors/MBA, ACCTG/MPACC and INFSY/MIS at Harrisburg

Date: August 2, 2016 at 11:27:09 AM EDT

To: "Charles H. Whiteman" <chwiteman@psu.edu>, Brian Cameron <bcameron@smeal.psu.edu>, Bill Kracaw <wak4@psu.edu>, "huddart@psu.edu" <huddart@psu.edu>, Vilmos Misangyi <vfm10@psu.edu>, Nicholas Petruzzi <ncp12@smeal.psu.edu>, RMHead <rmhead@smeal.psu.edu>, Hans Baumgartner <HansBaumgartner@psu.edu>

Cc: Mike Gilpatrick <mjg11@psu.edu>, Lorraine Reitz <lar8@psu.edu>, "Christine Jones" <ChristineJones@psu.edu>, Tammy Whitehill <tas1@psu.edu>, Tena Ishler <tri3@psu.edu>, Dawn Corman <drc18@psu.edu>, Lara Jackson <ljw21@psu.edu>, Stephanie Ironside <sli1@psu.edu>

Colleagues,

Please review carefully these proposals from the Harrisburg campus that appear primarily to be directed toward graduate programs. I am not sure how much, if any, consultation has taken place.

The proposals appear to be efforts to integrate undergraduate degrees with Harrisburg's MBA program. They are asking for our support.

Thanks,

Jeff

Jeffery M. Sharp | Associate Dean for Undergraduate Education
Smeal College of Business | The Pennsylvania State University | 202 Business Building | University Park, PA 16802
814 863-1947 (Office) | JeffSharp@psu.edu

---------------------------------------
Dear Dean Sharp,

Our School wants to provide opportunities to our outstanding undergraduate business students through IUGs. The IUGs include six undergraduate majors/MBA, Accounting/MPACC, and Information Systems/MIS. We respectfully request your help for the external review. Attached please find the proposals.

All proposals have similar admission requirements -- the number of seats is limited; candidates need to have 3.5 cumulative GPA and complete entry-to-major requirements. IUG students will count up to 12 credits of graduate courses toward their undergraduate degree.

If you have any questions, please feel free to let me know.

We appreciate your time and input.

Best regards,
Oranee

Oranee Tawatnuntachai, Ph.D., CFA
Associate Professor of Finance
Director, MBA Program
Penn State Harrisburg
Middletown, PA 17057
Tel. 717-948-6151
Fax 717-948-6456
Appendix E: B.S. in Information Systems and M.S.I.S. Integrated Undergraduate-Graduate (IUG) Handbook

B. S. in Information Systems and M.S.I.S. Integrated Undergraduate-Graduate (IUG) Degree Program
School of Business Administration
Penn State Harrisburg, the Capital College

1. Introduction

The School of Business Administration offers a limited number of academically superior Bachelor of Science in Information Systems candidates the opportunity to enroll in an integrated, continuous program of study leading to both the Bachelor of Science in Information Systems and the Master of Science in Information Systems. The ability to coordinate as well as concurrently pursue the two degree programs enables the students to earn both degrees in five years. Specifically, as many as twelve of the credits required for the master’s degree may be applied to both undergraduate and graduate degree programs. The Integrated Undergraduate-Graduate Program reduces the total number of credits needed to earn both degrees from 150 to 138.

2. Application Process

To initiate the application process, students must submit a resume, a personal statement including career goals and how M.S.I.S will enhance their career goals, official transcripts of all post-secondary courses taken outside Penn State, two letters of recommendation, with at least one from the School of Business Administration faculty, and a plan of study that integrates both undergraduate and graduate requirements. A graduate faculty adviser in collaboration with the Director of M.S.I.S. Program will help undergraduate candidates determine a sequence of courses that will prepare them for acceptance into the Integrated Undergraduate-Graduate (IUG) degree program.

Admission Requirements
The number of openings in the IUG program is limited. Applicants to the IUG program must have:

1. Completed a minimum of 60 credits. Students must be admitted to an IUG program no earlier than the beginning of the third semester of undergraduate study at Penn State (regardless of transfer or AP credits accumulated prior to enrollment) and no later than the end of the second week of the semester preceding the semester of expected conferral of the undergraduate degree.
2. Earned a minimum of cumulative grade point average of 3.5.
3. Completed the following Entry to Major courses or equivalent:
   • ACCTG 211 [4] Financial and Managerial Accounting for Decision Making
   • ECON 102 [3] Introductory Microeconomic Analysis and Policy
   • ENGL 015 or 030 [3] Rhetoric and Composition or Honors Freshmen Composition
   • FIN 301 [3] Corporation Finance
   • MGMT 301 [3] Basic Management Concepts
   • MKTG 301 [3] Principles of Marketing

To formally apply, students must submit a completed Graduate School application for admission. The students should mention in the notes section that the application is for the IUG program in Information Systems. The Graduate Management Admission Test (GMAT) or Graduate Record Examination (GRE) is not required for admission into the program; however, if students are interested in applying for a graduate assistantship, GMAT or GRE scores must be submitted by the end of the eighth semester.

Student applications will be evaluated based on their overall portfolio, in addition to the above requirements. In all cases, admission to the program will be at the discretion of the Graduate Admissions Committee in Information Systems.

**Reduced Course Load**
As many as twelve of the credits required for the master’s degree may be applied to both undergraduate and graduate degree programs. All courses proposed to count for both degrees must be at the 500- or 800-level. Below shows a sample sequence of coursework for the third, fourth and fifth year.
<table>
<thead>
<tr>
<th>Semester V</th>
<th>Semester VI</th>
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<tbody>
<tr>
<td>B A 241 Legal Environment of Business</td>
<td>SCM 301 Supply Chain Management</td>
</tr>
<tr>
<td>B A 242 Social and Ethical of Business</td>
<td>INFSY elective</td>
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<tr>
<td>ECON 104 Introductory Macroeconomics Analysis</td>
<td>MIS 448 Business Telecommunications</td>
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<td>MIS 307 Algorithmic Concepts</td>
<td>Sciences GN</td>
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<tr>
<td>MIS 465 Database Management</td>
<td>Arts GA</td>
</tr>
<tr>
<td>Non-Business elective</td>
<td>Non-Business elective</td>
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<tr>
<td>Health and Physical Activity GHA</td>
<td>17.5</td>
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<tr>
<th>Semester VII</th>
<th>Semester VIII</th>
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<tbody>
<tr>
<td>B A 364Y International Business and Society US; IL</td>
<td>B A 462 Business Strategy</td>
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<tr>
<td>Business support</td>
<td>3</td>
</tr>
<tr>
<td>INFSY 540* IT and Knowledge Mgmt</td>
<td>MIS 450 Systems Design Project</td>
</tr>
<tr>
<td>INFSY 535* Object-oriented Design</td>
<td>500 level INFSY elective*</td>
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<tr>
<td>12</td>
<td>3</td>
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<table>
<thead>
<tr>
<th>Semester IX</th>
<th>Semester X</th>
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</thead>
<tbody>
<tr>
<td>500 level INFSY Elective</td>
<td>INFSY 554 Master’s Project</td>
</tr>
<tr>
<td>500 level INFSY Elective</td>
<td>3</td>
</tr>
<tr>
<td>500-level Business Elective</td>
<td>500 level INFSY Elective</td>
</tr>
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<td>9</td>
<td>3</td>
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</tbody>
</table>

* Satisfies requirements for both the undergraduate and graduate programs for a total of 12 credits.

Eligibility for a Graduate Assistantship

Students in the IUG program will be eligible for consideration for a graduate assistantship to be awarded beginning of the fifth year. To be eligible for a graduate assistantship, students must have completed the requirements for their B.S. in Information Systems degree. The GMAT or GRE scores must be submitted by the end of the eighth semester to be considered for the assistantship.

3. IUG Degree Requirements

Students in the IUG program must satisfy the requirements for both the Bachelor of Science in Information Systems and Master of Science in Information Systems degrees, as listed in Appendix A and Appendix C. As outlined in the Reduced Course Load section above, the total course load is reduced due to courses that can count towards both degrees. The first two years of the IUG program are identical to the first two years of the Bachelor of Science program, listed in Appendix B. Students in the IUG program take five additional credits in their third year, and five fewer credits in their fourth year. The courses that count toward the Master of Science in Information Systems degree requirements are included in the fourth year.

Student performance will be monitored on an on-going basis. In addition, a formal evaluation of student academic performance will be performed when the students have completed 100 to
105 credits, which is at the end of the first semester of the senior year for typical students in the program. Students who have not maintained a 3.0 GPA in their graduate courses will be put on probationary status with respect to the IUG program. They will receive a warning letter regarding probationary status. Their ability to continue in the IUG program will be based on their academic performance in the last semester of their senior year.

If for any reason students admitted to the IUG program are unable to complete the requirements for the Master of Science in Information Systems degree, the students will be permitted to receive the Bachelor of Science in Information Systems degree assuming all the undergraduate degree requirements have been satisfactorily completed. If the students successfully complete courses listed in the recommended schedule, they will satisfy the requirements for the Bachelor of Science degree by the end of their fourth year.
Appendix A: Bachelor of Science in Information Systems Degree Requirements

**General Education Requirements (47 credits)**

- **Writing/Speaking (GWS)**
  - ENGL 015S or 030 [3]  Rhetoric and Composition or Honors Freshmen Composition†
  - CAS 100 [3]   Effective Speech

- **Quantitative (GQ)**
  - MATH 110 or 140 [4]   Techniques of Calculus I or Calculus with Analytic Geometry I^a
  - STAT 200 or SCM 200 [4]   Elementary Statistics or Introduction to Statistics for Business^a

- **Natural Sciences (GN)**
  9 credits of any courses with a GN suffix

- **Arts (GA)**
  6 credits of any courses with a GA suffix^b

- **Humanities (GH)**
  6 credits of any courses with a GH suffix^b

- **Social & Behavioral Sciences (GS)**
  - ECON 102 [3]   Introductory Microeconomic Analysis and Policy^a
  3 credits of any courses with a GS suffix^b

- **Health & Physical Activities (GHA)**
  3 credits of any courses with a GHA suffix

^aEntry to Major requirements
^bStudents may apply 9-6-3 rule.

**General Electives (8 credits)**

8 credits of non-business courses
Major Requirements (79 credits, including 3 credits of GWS courses, 6 credits of GQ courses and 3 credits of GS courses)

- Prescribed Courses (49 credits)
  - Business Courses (37 credits)
    - B A 364Y [3; US/IL] International Business and Society
    - ECON 102 [3; GS] Introductory Microeconomic Analysis and Policy
    - ECON 104 [3] Introductory Macroeconomic Analysis and Policy
    - ENGL 202D [3; GWS] Effective Writing: Business Writing
    - FIN 301 [3] Corporation Finance
    - MIS 204 [3] Introductory to Business Information Systems
    - MKTG 301 [3] Principles of Marketing
    - SCM 301 [3] Supply Chain Management
  - Information Systems Courses (12 credits)
    - MIS 448 [3] Business Data Communications

- Additional Courses (24 credits)
  - Math, Statistics and Law (12 credits)
    - Select 3 credits from CMPSC 101 [4; GQ] or CMPSC 121 [4; GQ] or IST 140 [3]
    - CMPSC 101 [4] Introduction to C++ Programming
    - CMPSC 121 [4] Introduction to Programming Techniques
    - IST 140 [3] Introduction to Application Development
    - Select 4 credits from MATH 110 [4; GQ] or MATH 140 [4; GQ]
    - Select 4 credits from SCM 200 [4; GQ] or STAT 200 [4; GQ]
    - B A 243 [4] Social, Legal, and Ethical Environment for Business
  - Information Systems Electives (9 credits)
    - Select 9 credits from one of the following three areas of concentration A, B, or C:
      - A. Application Development Concentration
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>MIS 413</td>
<td>Interface Design for Information Systems Applications</td>
</tr>
<tr>
<td>MIS 466</td>
<td>Business Programming for the WEB</td>
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<tr>
<td>MIS 489</td>
<td>Seminar in Information Systems</td>
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B. Network Security Concentration

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<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>IST 302</td>
<td>IT Project Management</td>
</tr>
<tr>
<td>IST 451</td>
<td>Network Security</td>
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<tr>
<td>IST 456</td>
<td>Information Security Management</td>
</tr>
<tr>
<td>MIS 489</td>
<td>Seminar in Information Systems</td>
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C. Individualized Concentration

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<thead>
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<th>Course Title</th>
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<tbody>
<tr>
<td>IST 302</td>
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<tr>
<td>IST 456</td>
<td>Information Security Management</td>
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<tr>
<td>MIS 413</td>
<td>Interface Design for Information Systems Applications</td>
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<tr>
<td>MIS 446</td>
<td>Information Technology and Business Strategy</td>
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<td>MIS 461</td>
<td>Web Technologies</td>
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<td>Business Programming for the WEB</td>
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<tr>
<td>MIS 489</td>
<td>Seminar in Information Systems</td>
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</tbody>
</table>

- Supporting Courses and Related Areas (9 credits)
  Select 9 credits from 200-400 level business courses from: ACCTG, B A, ECON, FIN, MGMT, MIS, MKTG, or SCM in consultation with an academic adviser and in support of the student’s interests.

**Additional Requirements**

- First-Year Seminar, 1 credit of any course with an S, T, X or PSU designation.
- United States Cultures and International Cultures requirements: 3 credits of any course with a US designation and 3 credits of any course with an IL designation. These are satisfied simultaneously with any of the above requirements.
- Writing across the Curriculum requirement is satisfied by B A 364Y, a prescribed course.
- No more than 60 credits should be from business and business-related courses.
### Appendix B: Bachelor of Science in Information Systems Typical Schedule

<table>
<thead>
<tr>
<th>Semester I</th>
<th>Semester II</th>
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<tbody>
<tr>
<td><strong>ENGL 015</strong> or <strong>030 Composition GWS</strong></td>
<td><strong>CAS 100 Effective Speech GWS</strong></td>
</tr>
<tr>
<td><strong>MATH 110 or 140 Calculus GQ</strong></td>
<td>*<strong>STAT 200 or SCM 200 Statistics GQ</strong></td>
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<tr>
<td><strong>Humanities GH</strong></td>
<td>*<strong>MGMT 301 Basic Management concepts</strong></td>
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<tr>
<td><strong>ECON 102 Introductory Microeconomic Analysis GS</strong></td>
<td><strong>Arts GA</strong></td>
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<tr>
<td>Health and Physical Activity GHA</td>
<td><strong>Sciences GN</strong></td>
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<thead>
<tr>
<th>Semester III</th>
<th>Semester IV</th>
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<tbody>
<tr>
<td>*<strong>ACCTG 211 Financial and Managerial Accounting</strong></td>
<td>*<strong>FIN 301 Corporation Finance</strong></td>
</tr>
<tr>
<td><strong>MKTG 301 Principles of Marketing</strong></td>
<td>IST 140 or CMPSC 101 or CMPSC 121</td>
</tr>
<tr>
<td>MIS 204 Introduction of Business Information Systems</td>
<td>Introduction to Programming GQ</td>
</tr>
<tr>
<td><strong>Humanities GH</strong></td>
<td><strong>ENGL 202D Business Writing</strong></td>
</tr>
<tr>
<td>Social and Behavioral Sciences GS</td>
<td><strong>Sciences GN</strong></td>
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<tr>
<td></td>
<td><strong>MIS 390 Information Systems Management and App</strong></td>
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<td><strong>16</strong></td>
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<tr>
<th>Semester V</th>
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<tr>
<td><strong>B A 241 Legal Environment of Business</strong></td>
<td><strong>SCM 301 Supply Chain Management</strong></td>
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<td><strong>Arts GA</strong></td>
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**Bold type** requires a grade of C or better.

*a* Entry to major requirement

*a* Business support – select from 200-400 level Business courses from: B A, FIN, MIS, MGMT, MKTG, SCM or ACCTG in consultation with an academic adviser and in support of the student’s interests

*b* Information Systems elective – select from one of the following three areas of concentration A, B, or C:

A. Application Development Concentration - IST 302 IT Project Management; IST 413 Interface Design for Information Systems Applications; IST 466 Business Programming for the WEB; MIS 489 Seminar in Information Systems

B. Network Security Concentration - IST 302 IT Project Management; IST 451 Network Security

IST 456 Information Security Management; MIS 489 Seminar in Information Systems

C. Individualized Concentration - IST 302 IT Project Management; IST 451 Network Security; IST 456 Information Security Management; MIS 413 Interface Design for Information Systems Applications; MIS 446 Information Technology and Business Strategy; MIS 461 Web Technologies; MIS 466 Business Programming for the WEB; MIS 489 Seminar in Information Systems
Appendix C: Master of Science in Information Systems Degree Requirements

The M.S.I.S. program requires, excluding pre-program requirements, 30 credits of course work at the graduate level (500-level or higher).

These are distributed over three groups of courses: Prescribed Courses, Additional Courses, and Electives.

M.S.I.S. Degree Program

Master of Science in Information Systems

Prescribed Courses
INFSY 535. Object-Oriented Design and Program Development (3)
INFSY 540. Information Technology and Knowledge Management (3)
INFSY 554. Master's Project (3)

Additional Courses (choose 15 credits)
INFSY 543. Electronic Commerce (3)
INFSY 587. Global Information Technology (3)
INFSY 547. Web Enabled Technologies (3)
INFSY 555. Data Management (3)
INFSY 556. Data Warehousing (3)
INFSY 560. Data Communications Systems and Networks (3)
INFSY 563. Network Security Management (3)
INFSY 565. Intelligent Systems (3)
INFSY 566. Data Mining and Knowledge Discovery (3)
INFSY 570. Software Engineering in the Analysis and Design of Information Systems (3)
INFSY 575. Seminar in Information Technology Management (3)
INFSY 590. Colloquium in Information Systems

Electives (6 credits)

Elective courses allow students to select additional elective courses of interest. Six credits of elective courses should be taken from 500-level courses offered by Penn State Harrisburg's School of Business Administration.
M.S.I.S. Bulletin Changes

1. Brief summary of proposed changes and justification for changes

We propose an Integrated Undergraduate Graduate (IUG) program in Information Systems at Penn State Harrisburg. This requires an update to the program bulletin. The updated section is in bold in Section 3.

2. Current bulletin description

Information Systems (INFSY)

Program Home Page (Opens New Window)

GIRISH H. SUBRAMANIAN, Program Director
Penn State Harrisburg
School of Business Administration
777 W. Harrisburg Pike
Middletown, PA 17057-4898
717-948-6140
M.S.I.S.hbg@psu.edu

Degree Conferred

M.S.

The Graduate Faculty

The Program

Operating under the auspices of the School of Business Administration, Penn State Harrisburg's master's degree program in information systems is designed to meet the rapidly increasing need for technically grounded, upper-level information resources managers within business organizations. With the exception of a small percentage of students who are full-time, the students served by the M.S.I.S. program are employees of area businesses, state and local governments, and not-for-profit organizations who study on a part-time basis. In order to accommodate both full- and part-time students, courses are primarily offered in the evening.

The two-fold nature of the program requires a manager to have competence both in information technology and in management theory; therefore, the curriculum combines the highly technical content of information science with the managerial emphasis of information systems. Unlike
computer science programs, which tend to focus on computer hardware and architecture, this program is organized around applied computer-based activities, the development of communication skills, and managerial principles.

**Admission Requirements**

Requirements listed here are in addition to requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin. Applicants apply for admission to the program via the Graduate School application for admission.

Admission decisions are based primarily on undergraduate junior-senior grade-point average and the Graduate Management Admissions Test (GMAT) scores or Graduate Record Exam (GRE) scores. Post-baccalaureate course work, professional experience, and the statements provided in the application are also taken into account.

Students are required to submit the following:

- a completed Graduate School application with application fee;
- official transcripts from all post-secondary institutions attended;
- official scores from the GMAT test or GRE test (the test must have been taken within the past five years); and
- letters of recommendation (optional).

**Application Dates**

Candidates may enter the program at the beginning of the fall, spring, or summer session. To allow time for applications to be processed, all information, including GMAT or GRE score, must be received by Graduate Enrollment Services no later than July 18 for admission to the fall semester, November 18 for admission to the spring semester, and April 18 for admission to the summer session.

Applicants from outside the United States must follow the early admission dates in order to allow the necessary clearances and paperwork to be processed in time. International application deadline dates are:

- Fall Semester--May 31
- Spring Semester--September 30
- Summer Session--February 28

To be considered for a graduate assistantship, applicants must submit a complete application by March 1.
Entry Requirements

Analytic Skills Requirement: Prior to enrolling in their M.S.I.S. course work, students are required to demonstrate competence in Analytic skills. This requirement may be demonstrated by: (1) satisfactory completion of a college-level mathematics course or (2) successful completion of a mathematics proficiency examination approved by the M.S.I.S. program. This requirement must be taken either during the first semester or summer session before the student's matriculation and completed with a grade of C or better.

Computer Skills Requirement: Students are required to demonstrate proficiency in the use of computer applications. This requirement can be satisfied through completion of a college-level computer applications or information systems course within the past five years with a grade of B or higher or by documented significant computer-related work experience. If this requirement has not been met prior to admission, a college-level computer-based information systems course such as MIS 204 is required. Course work must be taken either during the first semester or summer session before the student's matriculation and completed with a grade of B or higher.

Communication Skills Requirement: Successful completion of the M.S.I.S. program requires the ability to think clearly and to write and speak persuasively. Part of this requirement can be met by obtaining a score of "4" or more on the Graduate Management Admission Test (GMAT) or Graduate Record Exam (GRE) Analytical Writing Assessment (AWA). If this score is not achieved, students must satisfy this requirement through additional course work in writing skills or other work developed in consultation with the M.S.I.S. Program. This requirement must be satisfied during the first semester or summer session before the student's matriculation and completed with a grade of B or higher. The speech component of this requirement is satisfied through individual and group presentations in courses in the M.S.I.S. Program.

Pre-Program Requirement: The Pre-program requirement provides a basic foundation in theory, tools, and techniques required for the management of profit and non-profit organizations. It also provides a basic understanding of applications of financial accounting, the creation and distribution of goods and services, business and how people relate to others in various organizations, helping to merge two related disciplines: business and information systems. Students who have completed the appropriate pre-program courses previously must have completed the courses with a grade of B or higher within seven years prior to admission, or through equivalent graduate course work completed with a B or higher within seven years prior to admission, or college level course work validated by recent work experience. Students who have not met these tests of relevancy, grade, or currency prior to admission to the program must take these courses at the graduate level and early in program.

Pre-Program Requirement: 9 credits
BUS 505 and select 6 credits from: ACCT 501, MNGMT 511, BUSEC 502

Degree Requirements

Requirements listed here are in addition to requirements stated in the DEGREE REQUIREMENTS section of the Graduate Bulletin.
The M.S.I.S. degree program requires, excluding pre-program requirements, 30 credits of course work at the 500 or 800 level, with a minimum of 18 credits at the 500 level. The M.S.I.S. degree requires 9 credits of prescribed courses: INFSY 535 Object-Oriented Design and Program Development in Business (3), INFSY 540 Information Technology and Knowledge Management (3), and INFSY 554 Master’s Project (3). Students are also required to take 15 credits of Information Systems courses from an approved list available in the program office. Students also must take 6 credits of electives from the 500-level courses offered by Penn State Harrisburg’s School of Business Administration. The INFSY 554 Master’s Project course involves development of an original master’s project in the student’s field of interest and preparation of a scholarly paper.

**Data Analytics Track:** The objective of this Track is to provide the student with data analytical skills that enable them to gain data insights and transform data into strategic decisions.

In consultation with their adviser, a student shall select 9 credits from the following:

- BUS 510 Business Analytics and Decision Modeling (3)
- INFSY 555 Data Management Systems (3)
- INFSY 556 Data Warehousing (3)
- INFSY 565 Intelligent Systems in Business (3)
- INFSY 566 Data Mining and Knowledge Discovery (3)
- INFSY 547 Web Enabled Technologies (3)

**Transfer Credits**

Penn State allows a maximum of 10 transfer credits of high-quality graduate work to be applied toward the requirements for a graduate degree, subject to restrictions outlined in the Transfer Courses section of the Graduate Bulletin. It must be the opinion of the reviewing faculty that these courses are equivalent in quality to those offered at Penn State Harrisburg. Credit will not be given for any class used to complete a previous degree.

**Course Substitutions**

Because some students enter the Program with advanced knowledge in one or more subject areas, up to six credits in prescribed or additional courses may be replaced with more advanced graduate courses in the same subject area. Except for INFSY 554, which must be taken at the College, INFSY prescribed and additional courses, in cases where there is equivalent knowledge, must be replaced with more advanced courses in the same field. Substitutions are based on a minimum of six credits of advanced undergraduate course work in an area of concentration or credits earned in an equivalent graduate-level program at a regionally accredited, college-level institution. These courses must have been completed within the past five years and have earned a grade of B or better. Substituted courses must be replaced with other advanced graduate courses in the field for which the substitute is the foundation/prerequisite. Substitutions are based on past academic performance. An examination cannot be used for earned graduate course credit.
Grade-Point Average and Time Limit

A 3.00 (out of 4.00) minimum grade-point average is required for the award of the M.S.I.S. degree. All course work must be completed within eight years of admission to degree status.

CONCURRENT DEGREE OFFERINGS WITH THE PENN STATE COLLEGE OF MEDICINE, BIOMEDICAL SCIENCES GRADUATE PROGRAM

Penn State Harrisburg, School of Business Administration
The Penn State College of Medicine, Biomedical Sciences (BMS) Graduate Program

Degrees Conferred

Ph.D. (College of Medicine)
M.S.I.S. (Penn State Harrisburg)

Concurrent Degree Programs

The Penn State College of Medicine, Biomedical Sciences Graduate Program, and the School of Business Administration of Penn State Harrisburg offer cooperative programs leading to the degrees of Doctor of Philosophy (Ph.D.) to be granted by the Penn State College of Medicine, and the Master of Science in Information Systems (M.S.I.S.) to be granted by Penn State Harrisburg. These concurrent degree opportunities facilitate the completion of both a pharmacology doctorate and a professional degree in information systems. The programs are designed primarily for students interested in pursuing a career involving high-quality independent research and positions of management responsibility within the pharmacological community.

Admission Requirements

The concurrent programs require that the student first be admitted to the biomedical sciences program. Subsequently, the student is recommended for and applies for admission to the Graduate School for the Penn State Harrisburg M.S.I.S. program.

The following are required for applicants:

*Biomedical Sciences*: Completed application; Graduate Record Examination (GRE) Score; A bachelor's degree reflecting a reasonable background in zoology or biology, mathematics and chemistry; a minimum junior/senior grade point average of 3.00 and with appropriate course backgrounds; two letters of recommendation; a curriculum vitae; a description of career goals. Reading knowledge of one or two foreign languages is recommended.

*M.S.I.S. Programs*: Applicants must meet the admission requirements of the Graduate School, as well as those listed in the Admission Requirements section above for the Master of Science
degree. In addition, a letter of recommendation from the department chair of the biomedical sciences program is required.

No courses from the M.S.I.S. program may count toward the Ph.D. until the student is admitted to the biomedical sciences program. However, graduate-level courses taken in the M.S.I.S. program at Penn State Harrisburg or at another graduate-level institution may be applied to the M.S.I.S. in accordance with the transfer policies of Graduate Council.

It is anticipated that most students in the concurrent programs will require additional graduate credits in order to satisfy the entry and pre-program requirements in business administration. To earn the M.S. degree in Information Systems, students in the concurrent degree program must complete all of the degree requirements for the M.S. degree, described above. Six credits of biomedical sciences core requirement credits may be double-counted toward the M.S.I.S., and four credits of M.S.I.S. course work may be double-counted towards the BMS Ph.D. The six credits from BMS that are eligible to be double-counted are BMS 502 (3) and BMS 503 (3). The four credits of M.S.I.S. program that are eligible to be double-counted are the INFSY 540 (3) and INFSY 596 (1). Students must obtain a grade satisfactory to the program in order for the credits to be double-counted.

All students in the concurrent program have two advisers, one in the School of Business Administration and one from the faculty in the Biomedical Sciences Graduate Program. Because the concurrent program is designed to be taken in synchrony with the objective that both degrees will be earned simultaneously, students who do not demonstrate progress toward completion of both degrees may be denied continuation in the concurrent program. Such a decision will rest jointly with the faculties of the M.S.I.S. and the Ph.D. programs. If students accepted into the concurrent degree program are unable to complete the Ph.D. degree, they are still eligible to receive the M.S.I.S. degree if all the M.S.I.S. degree requirements have been satisfied.

The Course Matrix

For more information and the latest updates on the concurrent programs, call the Biomedical Sciences Graduate Program at 717-531-1045 or visit the websites at: Biomedical Sciences Graduate Program and Penn State Harrisburg.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the Student Aid section of the Graduate Bulletin. There are a limited number of scholarships, fellowships, and research grants available, as well as several graduate assistantships. For more information on these, contact Penn State Harrisburg’s School of Business Administration.

Many students work full-time and take classes part-time. In many cases, employers have a tuition-reimbursement plan paying for partial or full tuition. To find other options available to you, contact one of the following offices: Financial Aid Office, 717-948-6307 or Admissions, 717-948-6250.
Graduate School Assistantships

Full time graduate students who are interested in an assistantship should contact the graduate program coordinator. Students must be nominated for an assistantship by their program coordinator. Students applying for an assistantship should submit scores from the Graduate Management Admissions Test (GMAT), Graduate Record Exam (GRE) or similar examinations by January 30. Students on graduate assistantships must adhere to the course load limits set forth in the Graduate Bulletin.

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.

BUSINESS ADMINISTRATION (BUSAD) course list

INFORMATION SYSTEMS (INFSY) course list

3. Revised bulletin description

Information Systems (INFSY)

Program Home Page (Opens New Window)

GIRISH H. SUBRAMANIAN, Program Director
Penn State Harrisburg
School of Business Administration
777 W. Harrisburg Pike
Middletown, PA 17057-4898
717-948-6140
M.S.I.S.hbg@psu.edu

Degree Conferred

M.S.

The Graduate Faculty
The Program

Operating under the auspices of the School of Business Administration, Penn State Harrisburg's master’s degree program in information systems is designed to meet the rapidly increasing need for technically grounded, upper-level information resources managers within business organizations. With the exception of a small percentage of students who are full-time, the students served by the M.S.I.S. program are employees of area businesses, state and local governments, and not-for-profit organizations who study on a part-time basis. In order to accommodate both full- and part-time students, courses are primarily offered in the evening.

The two-fold nature of the program requires a manager to have competence both in information technology and in management theory; therefore, the curriculum combines the highly technical content of information science with the managerial emphasis of information systems. Unlike computer science programs, which tend to focus on computer hardware and architecture, this program is organized around applied computer-based activities, the development of communication skills, and managerial principles.

Admission Requirements

Requirements listed here are in addition to requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin. Applicants apply for admission to the program via the Graduate School application for admission.

Admission decisions are based primarily on undergraduate junior-senior grade-point average and the Graduate Management Admissions Test (GMAT) scores or Graduate Record Exam (GRE) scores. Post-baccalaureate course work, professional experience, and the statements provided in the application are also taken into account.

Students are required to submit the following:

- a completed Graduate School application with application fee;
- official transcripts from all post-secondary institutions attended;
- official scores from the GMAT test or GRE test (the test must have been taken within the past five years); and
- letters of recommendation (optional).

Application Dates

Candidates may enter the program at the beginning of the fall, spring, or summer session. To allow time for applications to be processed, all information, including GMAT or GRE score, must be received by Graduate Enrollment Services no later than July 18 for admission to the fall semester, November 18 for admission to the spring semester, and April 18 for admission to the summer session.
Applicants from outside the United States must follow the early admission dates in order to allow the necessary clearances and paperwork to be processed in time. International application deadline dates are:

- Fall Semester--May 31
- Spring Semester--September 30
- Summer Session--February 28

To be considered for a graduate assistantship, applicants must submit a complete application by March 1.

**Entry Requirements**

Credits obtained to fulfill entry and pre-program requirements cannot be applied towards the requirements for the degree.

*Analytic Skills Requirement:* Prior to enrolling in their M.S.I.S. course work, students are required to demonstrate competence in Analytic skills. This requirement may be demonstrated by: (1) satisfactory completion of a college-level mathematics course or (2) successful completion of a mathematics proficiency examination approved by the M.S.I.S. program. This requirement must be taken either during the first semester or summer session before the student's matriculation and completed with a grade of C or better.

*Computer Skills Requirement:* Students are required to demonstrate proficiency in the use of computer applications. This requirement can be satisfied through completion of a college-level computer applications or information systems course within the past five years with a grade of B or higher or by documented significant computer-related work experience. If this requirement has not been met prior to admission, a college-level computer-based information systems course such as MIS 204 is required. Course work must be taken either during the first semester or summer session before the student's matriculation and completed with a grade of B or higher.

*Communication Skills Requirement:* Successful completion of the M.S.I.S. program requires the ability to think clearly and to write and speak persuasively. Part of this requirement can be met by obtaining a score of "4" or more on the Graduate Management Admission Test (GMAT) or Graduate Record Exam (GRE) Analytical Writing Assessment (AWA). If this score is not achieved, students must satisfy this requirement through additional course work in writing skills or other work developed in consultation with the M.S.I.S. Program. This requirement must be satisfied during the first semester or summer session before the student's matriculation and completed with a grade of B or higher. The speech component of this requirement is satisfied through individual and group presentations in courses in the M.S.I.S. Program.

*Pre-Program Requirement:* The Pre-program requirement provides a basic foundation in theory, tools, and techniques required for the management of profit and non-profit organizations. It also provides a basic understanding of applications of financial accounting, the creation and distribution of goods and services, business and how people relate to others in various organizations, helping to merge two related disciplines: business and information systems.
Students who have completed the appropriate pre-program courses previously must have completed the courses with a grade of B or higher within seven years prior to admission, or through equivalent graduate course work completed with a B or higher within seven years prior to admission, or college level course work validated by recent work experience. Students who have not met these tests of relevancy, grade, or currency prior to admission to the program must take these courses at the graduate level and early in program.

Pre-Program Requirement: 9 credits
BUS 505 and select 6 credits from: ACCT 501, MGMT 511, BUSEC 502

**Degree Requirements**

Requirements listed here are in addition to requirements stated in the DEGREE REQUIREMENTS section of the Graduate Bulletin.

The M.S.I.S. degree program requires, excluding pre-program requirements, 30 credits of course work at the 500 or 800 level, with a minimum of 18 credits at the 500 level. The M.S.I.S. degree requires 9 credits of prescribed courses: INFSY 535 Object-Oriented Design and Program Development in Business (3), INFSY 540 Information Technology and Knowledge Management (3), and INFSY 554 Master’s Project (3). Students are also required to take 15 credits of Information Systems courses from an approved list available in the program office. Students also must take 6 credits of electives from the 500-level courses offered by Penn State Harrisburg’s School of Business Administration. The INFSY 554 Master’s Project course involves development of an original master’s project in the student’s field of interest and preparation of a scholarly paper.

**Data Analytics Track:** The objective of this Track is to provide the student with data analytical skills that enable them to gain data insights and transform data into strategic decisions.

In consultation with their adviser, a student shall select 9 credits from the following:

- BUS 510 Business Analytics and Decision Modeling (3)
- INFSY 555 Data Management Systems (3)
- INFSY 556 Data Warehousing (3)
- INFSY 565 Intelligent Systems in Business (3)
- INFSY 566 Data Mining and Knowledge Discovery (3)
- INFSY 547 Web Enabled Technologies (3)

**Transfer Credits**

Penn State allows a maximum of 10 transfer credits of high-quality graduate work to be applied toward the requirements for a graduate degree, subject to restrictions outlined in the Transfer Courses section of the Graduate Bulletin. It must be the opinion of the reviewing faculty that these courses are equivalent in quality to those offered at Penn State Harrisburg. Credit will not be given for any class used to complete a previous degree.
Course Substitutions

Because some students enter the Program with advanced knowledge in one or more subject areas, up to six credits in prescribed or additional courses may be replaced with more advanced undergraduate or graduate courses in the same subject area. Except for INFSY 554, which must be taken at the College, INFSY prescribed and additional courses, in cases where there is equivalent knowledge, must be replaced with more advanced courses in the same field. Substitutions are based on a minimum of six credits of advanced undergraduate course work in an area of concentration or credits earned in an equivalent graduate-level program at a regionally accredited, college-level institution. These courses must have been completed within the past five years and have earned a grade of B or better. Substituted courses must be replaced with other advanced graduate courses in the field for which the substitute is the foundation/prerequisite. Substitutions are based on past academic performance. An examination cannot be used for earned graduate course credit.

Integrated B.S. in Information Systems/M.S.I.S Program

The School of Business Administration offers a limited number of academically superior Bachelor of Science in Information Systems candidates the opportunity to enroll in an integrated, continuous program of study leading to both the Bachelor of Science in Information Systems and the Master of Science in Information Systems. The ability to coordinate as well as concurrently pursue the two degree programs enables the students to earn both degrees in five years. Specifically, as many as twelve of the credits required for the master’s degree may be applied to both undergraduate and graduate degree programs.

If for any reason students admitted to the IUG program are unable to complete the requirements for the Master of Science in Information Systems degree, the students will be permitted to receive the Bachelor of Science in Information Systems degree assuming all the undergraduate degree requirements have been satisfactorily completed.

ADMISSION REQUIREMENTS

Students apply to the program via the Graduate School application for admission, and must meet the admission requirements of the Graduate School, as well as the admission requirements for the Master of Science degree in Information Systems, listed above. Students should mention in the notes section that the application is for the IUG program in Information Systems.

Students must submit a resume, a personal statement including career goals and how the M.S.I.S. will enhance their career goals, official transcripts of all post-secondary courses taken outside Penn State, two letters of recommendation, with at least one from the School of Business Administration faculty, and a plan of study that integrates both undergraduate and graduate requirements. The plan should cover the entire time period of the integrated program, and it should be reviewed periodically with an adviser as the student advances through the program. A graduate faculty adviser in collaboration with the Director of M.S.I.S. Program will help
undergraduate candidates determine a sequence of courses that will prepare them for acceptance into the Integrated Undergraduate-Graduate (IUG) degree program.

The Graduate Management Admission Test (GMAT) or Graduate Record Examination (GRE) is not required for admission into the program; however, if students are interested in a graduate assistantship, GMAT or GRE scores must be submitted by the end of the eighth semester.

The number of openings in the IUG program is limited. Applicants to the IUG program must have completed a minimum of 60 credits. Students must be admitted to an IUG program no earlier than the beginning of the third semester of undergraduate study at Penn State (regardless of transfer or AP credits accumulated prior to enrollment) and no later than the end of the second week of the semester preceding the semester of expected conferral of the undergraduate degree. In addition, the applicants must earn a minimum of cumulative grade point average of 3.5 and complete the following Entry to Major courses or equivalent: ACCTG 211 [4], ECON 102 [3], ENGL 015 or 030 [3], FIN 301 [3], MATH 110 or 140 [4], MGMT 301 [3], MKTG 301 [3] and STAT 200 [4] or SCM 200 [4].

Student applications will be evaluated based on their overall portfolio, in addition to the above requirements. In all cases, admission to the program will be at the discretion of the Graduate Admissions Committee in Information Systems.

**DEGREE REQUIREMENTS**

Students must fulfill all degree 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 Bachelor of Science in Information Systems are listed in the Undergraduate Bulletin. Degree requirements for the Master of Science in Information Systems degree are listed above. Students must sequence their courses so all undergraduate degree requirements are fulfilled before taking courses to count towards the graduate degree.

Up to 12 credits may be double-counted towards the degree requirements for both undergraduate and graduate degrees. All courses counted for both degrees must be at the 500- or 800-level. Credits associated with the culminating experience for the graduate degree cannot be double-counted.

The courses that will double count for both degrees include: INFSY 535, INFSY 540, INFSY 555, INFSY 560, INFSY 547, INFSY 543 and INFSY 570.

**Student Aid**

Graduate assistantships available to students in this program and other forms of student aid are described in the Student Aid section of the Graduate Bulletin. There are a limited number of scholarships, fellowships, and research grants available, as well as several graduate
assistantships. For more information on these, contact Penn State Harrisburg’s School of Business Administration.

Many students work full-time and take classes part-time. In many cases, employers have a tuition-reimbursement plan paying for partial or full tuition. To find other options available to you, contact one of the following offices: Financial Aid Office, 717-948-6307 or Admissions, 717-948-6250.

**Graduate School Assistantships**

Full time graduate students who are interested in an assistantship should contact the graduate program coordinator. Students must be nominated for an assistantship by their program coordinator. Students applying for an assistantship should submit scores from the Graduate Management Admissions Test (GMAT), Graduate Record Exam (GRE) or similar examinations by January 30. Students on graduate assistantships must adhere to the course load limits set forth in the *Graduate Bulletin*.

**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.

[**BUSINESS ADMINISTRATION (BUSAD) course list**](#)

[**INFORMATION SYSTEMS (INFSY) course list**](#)
Graduate Council
Program, Option, or Minor Proposal Form

Submit 1 original, signed Graduate Council proposal form and 2 hardcopies of the graduate program proposal document, with a copy of the signed proposal form attached to each proposal copy, to the Office of the Dean of the Graduate School, 211 Kern Building, University Park. For more information about the process, see the Overview of the Graduate Council Curricular Review Process.

The Program Proposal Procedures provide guidance for the development of a graduate program proposal. If you have questions regarding the preparation of a graduate program proposal or how to complete this Graduate Council proposal form, contact the Office of the Dean of the Graduate School.

College/School: Medicine
Department or Instructional Area: Public Health Sciences

New Graduate Program, Option, or Minor: Add
Designation of new graduate program:
Classification of Instructional Programs (CIP) Code: 
Designation of new graduate option:
Designation of new graduate minor:

Indicate effective semester:
First semester following approval
Second semester following approval

Existing Graduate Program Option, or Minor: Change
Current designation of graduate program: Public Health
Current designation of graduate option:
Current designation of graduate minor:
New designation of existing graduate program (if changing):
New designation of existing graduate option (if changing):
New designation of existing graduate minor (if changing):
Brief description of the change (if not noted above): Reducing MPH credits; changing Dr. PH core

Indicate effective semester:
First semester following approval
Second semester following approval

Submitted by Graduate Program Head
Wenke Hwang
Printed name
Date: 11-28-16
Signature

Noted by College/School Representative to Graduate Council Subcommittee on New and Revised Programs and Courses:
Printed name
Date: 12/1/16
Signature

Approved by College/School Dean/Chancellor (or Designee):
Printed name
Date: 12/1/16
Signature
<table>
<thead>
<tr>
<th>Role</th>
<th>Printed name</th>
<th>Signature</th>
<th>Date</th>
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<tr>
<td>Recommended by Chair, Graduate Council Subcommittee on New and Revised Programs and Courses:</td>
<td></td>
<td></td>
<td>3/7/2017</td>
</tr>
<tr>
<td>On Behalf of John Challis</td>
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<tr>
<td>Recommended by Chair, Graduate Council Committee on Programs and Courses:</td>
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<td>3/7/2017</td>
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<tr>
<td>On Behalf of M. Kathleen Heid</td>
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<tr>
<td>Noted by Dean of the Graduate School:</td>
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<td>3/7/2017</td>
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<tr>
<td>On Behalf of Regina Vasilatos-Younken</td>
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VIII. Letters of Support.......................................................... 23
I. **Justification for Proposed Changes**

We respectfully submit this program change proposal (1) to reduce the M.P.H. in Public Health from 45 credits to 42 credits; (2) to add PHS 806: Public Health Ethics to the core requirements of the Dr.P.H. degree program; and (3) to reduce the number of foundational courses for Dr.P.H. applicants without a Master of Public Health (M.P.H.) degree. The justification for each change is described below.

A. **Reduce M.P.H. degree from 45 to 42 credits**

To achieve a reduction in credits, we propose to remove PHS 542: Environmental Health Sciences (3 credits) from the program’s core requirements. Changes to the MPH in Public Health program are being proposed at this time to respond to national recommendations on the design of MPH programs.

In October 2016, the Council on Education for Public Health (CEPH), the national accrediting body for schools of public health and public health degree programs, adopted new foundational areas of public health with required competencies that all schools and programs must address through their respective core curricula. The table below outlines the former and new areas of public health.

<table>
<thead>
<tr>
<th>Public Health Areas prior to October 2016</th>
<th>Public Health Areas as of October 2016</th>
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</thead>
<tbody>
<tr>
<td>• Biostatistics</td>
<td>• Evidence-based approaches to public health</td>
</tr>
<tr>
<td>• Epidemiology</td>
<td>• Public health and health care systems</td>
</tr>
<tr>
<td>• Environmental health sciences</td>
<td>• Planning and management to promote health</td>
</tr>
<tr>
<td>• Health services administration</td>
<td>• Policy in public health</td>
</tr>
<tr>
<td>• Social and behavioral sciences</td>
<td>• Leadership</td>
</tr>
<tr>
<td></td>
<td>• Communication</td>
</tr>
<tr>
<td></td>
<td>• Interprofessional practice</td>
</tr>
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<td></td>
<td>• Systems thinking</td>
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</tbody>
</table>

Each new foundational area has a set of required competencies that must be addressed through the MPH core curriculum (excludes electives and areas of specialization that students may opt to pursue). The new foundational areas and mandated competencies substantively align with existing MPH core courses and the former core areas of biostatistics, epidemiology, health services administration, and social and behavioral sciences. However, “environmental health sciences” is not mentioned at all in the new foundational areas or related mandated competencies.

This change is based on a multi-year process initiated by CEPH to reexamine the needs of the field of public health and CEPH’s accreditation criteria. This process resulted in the consideration of more than 700 individual comments and feedback from the Association of Schools and Programs in Public Health (ASPPH), a national organization that represents the interests of 106 CEPH-accredited schools and programs in public health – including the Penn State M.P.H. degree program – the Association for Prevention Teaching and Research Council of Graduate Programs, the Council on Linkages Between Academia and Public Health, the Executive Board of the Association for Accredited Public Health Programs, the Association of University Programs in Health Administration, as well as representatives from the field of public health. The process is also based on a seminal report from ASPPH that was released in 2015, Framing the Future, A Master of Public Health Degree for the 21st Century (available at [http://www.aspph.org/app/uploads/2015/02/MPH1.pdf](http://www.aspph.org/app/uploads/2015/02/MPH1.pdf)). CEPH’s new mandated foundational areas
of public health are reflected in this report. This report also asserts that the minimum number of required credits for M.P.H. degree programs should not be raised above 42 credits.

Consensus in the field of public health and among CEPH-accredited schools and programs in public health is that requiring substantive core coursework in environmental health sciences is no longer within the overarching mission of an M.P.H. degree program and does not represent the current needs of public health. Based on CEPH’s thorough process and results, we feel that it would be a disservice to students and unethical to require a 3-credit course in a public health area that the field agrees is outside the scope of what is needed in future M.P.H.-trained professionals.

B. Add PHS 806: Public Health Ethics to Dr.P.H. Core Requirements

We propose to add PHS 806: Public Health Ethics as a core requirement and remove the option for students to take BIOET 501, BIOET 502, BUS 515, HPA 836, PHIL 432, HLS 803, BUSAD 551, HLTHL 961, or CAS 426W to satisfy the program’s ethics requirement. Although these listed courses offer students a broad understanding of important ethical concepts, we felt that it was critical to develop a new course that would address these concepts within the specific context of public health research and practice. According to the ASPPH, professionalism and ethics are “the ability to identify and analyze an ethical issue; balance the claims of personal liberty with the responsibility to protect and improve the health of the population; and act on the ethical concepts of social justice and human rights in public health research and practice” (ASPPH, 2009). This course will provide tools for ethical decision-making in public health.

C. Reduce the number of foundational courses for Dr.P.H. applicants without a Master of Public Health (M.P.H.) degree.

Consistent with the evidence presented in section IA, Dr.P.H. applicants without an M.P.H. degree will no longer need to take PHS 542: Environmental Health Science (3 credits) as a foundational course.

Reference:

## II. Overview of Program Changes: Side by Side Comparison

The tables below and continued on the next page provide a side-by-side comparison of the current and proposed M.P.H. and Dr.P.H. curricula, as well as a comparison of current and proposed prerequisites for the Dr.P.H. degree program. Courses below are presented as follows: course number: title (credit total). Differences are in bold.

<table>
<thead>
<tr>
<th>Current M.P.H. Curriculum (45 credits)</th>
<th>Proposed M.P.H. Curriculum (42 credits)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Core Didactic M.P.H. Courses (21 credits)</strong></td>
<td><strong>Core Didactic M.P.H. Courses (18 credits)</strong></td>
</tr>
<tr>
<td>- PHS 504: Behavioral Health Intervention Strategies (3) or BB H 504: Behavioral Health Intervention Strategies (3)</td>
<td>- PHS 504: Behavioral Health Intervention Strategies (3) or BB H 504: Behavioral Health Intervention Strategies (3)</td>
</tr>
<tr>
<td>- PHS 520: Principles of Biostatistics (3) or STAT 500: Applied Statistics (3)</td>
<td>- PHS 520: Principles of Biostatistics (3) or STAT 500: Applied Statistics (3)</td>
</tr>
<tr>
<td>- PHS 536: Health Survey Research Methods (3)</td>
<td>- PHS 536: Health Survey Research Methods (3)</td>
</tr>
<tr>
<td>- PHS 542: Environmental Health Sciences (3)</td>
<td>- PHS 542 Environmental Health Sciences (3)</td>
</tr>
<tr>
<td>- PHS 550: Principles of Epidemiology (3)</td>
<td>- PHS 550: Principles of Epidemiology (3) (Hershey)</td>
</tr>
<tr>
<td>- PHS 571: Health Services Organization and Delivery (3) or HPA 520: Introduction to Health Services Organizations and Delivery (3)</td>
<td>- PHS 571: Health Services Organization and Delivery (3) or HPA 520: Introduction to Health Services Organizations and Delivery (3)</td>
</tr>
<tr>
<td><strong>Practicum Experience (3 credits)</strong></td>
<td><strong>Practicum Experience (3 credits)</strong></td>
</tr>
<tr>
<td>- PHS 895A: Master of Public Health Internship (3)</td>
<td>- PHS 895A: Master of Public Health Internship (3)</td>
</tr>
<tr>
<td><strong>Culminating Experience (3 credits)</strong></td>
<td><strong>Culminating Experience (3 credits)</strong></td>
</tr>
<tr>
<td>- PHS 894: Capstone Experience (3)</td>
<td>- PHS 894: Capstone Experience (3)</td>
</tr>
<tr>
<td><strong>Electives (18 credits)</strong></td>
<td><strong>Electives (18 credits)</strong></td>
</tr>
<tr>
<td>- Students may (1) select from a pre-approved list of electives or (2) propose alternate electives for consideration and approval by the program.</td>
<td>- Students may (1) select from a pre-approved list of electives or (2) propose alternate electives for consideration and approval by the program.</td>
</tr>
<tr>
<td>- In addition to fulfilling the 18-credit elective requirement by selecting courses from the pre-approved list or by proposing alternate courses for consideration, students may specialize in a track for depth of training by selecting a specific configuration of pre-approved electives.</td>
<td>- In addition to fulfilling the 18-credit elective requirement by selecting courses from the pre-approved list or by proposing alternate courses for consideration, students may specialize in a track for depth of training by selecting a specific configuration of pre-approved electives.</td>
</tr>
<tr>
<td>Current Dr.P.H. Curriculum (60 credits)</td>
<td>Proposed Dr.P.H. Curriculum (60 credits)</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td><strong>Core Didactic Dr.P.H. Courses (24 credits)</strong></td>
<td><strong>Core Didactic Dr.P.H. Courses (24 credits)</strong></td>
</tr>
<tr>
<td>- PHS 575: Integrative Public Health Leadership (3)</td>
<td>- PHS 575: Integrative Public Health Leadership (3)</td>
</tr>
<tr>
<td>- PHS 577: Integrative Seminar in Social &amp; Behavioral Determinants of Health (3)</td>
<td>- PHS 577: Integrative Seminar in Social &amp; Behavioral Determinants of Health (3)</td>
</tr>
<tr>
<td>- PHS 576: Integrative Seminar in Public Health Policy (3)</td>
<td>- PHS 576: Integrative Seminar in Public Health Policy (3)</td>
</tr>
<tr>
<td>- PHS 554: Statistical Methods in Public Health I (3)</td>
<td>- PHS 554: Statistical Methods in Public Health I (3)</td>
</tr>
<tr>
<td>- PHS 555: Statistical Methods in Public Health II (3)</td>
<td>- PHS 555: Statistical Methods in Public Health II (3)</td>
</tr>
<tr>
<td>- ADTED 550: Qualitative Research Methodologies for Adult Education (3)</td>
<td>- ADTED 550: Qualitative Research Methodologies for Adult Education (3)</td>
</tr>
<tr>
<td>- Ethics (3) <em>(BIOET 501, BIOET 502, BUS 515, HPA 836, PHIL 432, HLS 803, BUSAD 551, HLTHL 961, or CAS 426W)</em></td>
<td>- PHS 806: Public Health Ethics (3)</td>
</tr>
<tr>
<td>- PHS 892: Directed Studies in Public Health (3)</td>
<td>- PHS 892: Directed Studies in Public Health (3)</td>
</tr>
<tr>
<td><strong>Advanced Field Experience (6 credits)</strong></td>
<td><strong>Advanced Field Experience (6 credits)</strong></td>
</tr>
<tr>
<td>- PHS 895B: Advanced Field Experience (6)</td>
<td>- PHS 895B: Advanced Field Experience (6)</td>
</tr>
<tr>
<td><strong>Integrative Doctoral Research (9 credits)</strong></td>
<td><strong>Integrative Doctoral Research (9 credits)</strong></td>
</tr>
<tr>
<td>- PHS 896A: Integrative Doctoral Research I (6)</td>
<td>- PHS 896A: Integrative Doctoral Research I (6)</td>
</tr>
<tr>
<td>- PHS 896B: Integrative Doctoral Research II (3)</td>
<td>- PHS 896B: Integrative Doctoral Research II (3)</td>
</tr>
<tr>
<td><strong>Electives (21 credits)</strong></td>
<td><strong>Electives (21 credits)</strong></td>
</tr>
<tr>
<td>- Students may (1) select from a pre-approved list of electives or (2) propose alternate electives for consideration and approval by the program.</td>
<td>- Students may (1) select from a pre-approved list of electives or (2) propose alternate electives for consideration and approval by the program.</td>
</tr>
<tr>
<td>- In addition to fulfilling the 21-credit elective requirement by selecting courses from the pre-approved list or by proposing alternate courses for consideration, students may specialize in a track for depth of training by selecting a specific configuration of pre-approved electives.</td>
<td>- In addition to fulfilling the 21-credit elective requirement by selecting courses from the pre-approved list or by proposing alternate courses for consideration, students may specialize in a track for depth of training by selecting a specific configuration of pre-approved electives.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Current Foundational Courses for Dr.P.H. applicants without an M.P.H. degree (15 credits)</th>
<th>Proposed Foundational Courses for Dr.P.H. applicants without an M.P.H. degree (12 credits)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- PHS 504: Behavioral Health Intervention Strategies (3)</td>
<td>- PHS 504: Behavioral Health Intervention Strategies (3)</td>
</tr>
<tr>
<td>- PHS 520: Principles of Biostatistics (3)</td>
<td>- PHS 520: Principles of Biostatistics (3)</td>
</tr>
<tr>
<td>- PHS 542: Environmental Health Sciences (3)</td>
<td>- PHS 542: Environmental Health Sciences (3)</td>
</tr>
<tr>
<td>- PHS 550: Principles of Epidemiology (3)</td>
<td>- PHS 550: Principles of Epidemiology (3)</td>
</tr>
<tr>
<td>- PHS 571: Health Services Organization and Delivery (3)</td>
<td>- PHS 571: Health Services Organization and Delivery (3)</td>
</tr>
</tbody>
</table>
III. Description of Proposed Changes

Each set of changes is described separately below.

A. Reduce M.P.H. degree from 45 to 42 credits

We propose to remove PHS 542: Environmental Health Sciences (3 credits) from the core requirements for the M.P.H. in Public Health program. This would reduce the core requirements from 27 credits to 24 credits, and it would reduce the program’s total credits from 45 credits to 42 credits. The resultant M.P.H. requirements would be as follows:

<table>
<thead>
<tr>
<th>Core credits</th>
<th>24 credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>• PHS 501: Principles of Public Health (3)</td>
<td></td>
</tr>
<tr>
<td>• PHS 504: Behavioral Health Intervention Strategies (3) or BB H 504: Behavioral Health Intervention Strategies (3)</td>
<td></td>
</tr>
<tr>
<td>• PHS 520: Principles of Biostatistics (3) or STAT 500: Applied Statistics (3)</td>
<td></td>
</tr>
<tr>
<td>• PHS 536: Health Survey Research Methods (3)</td>
<td></td>
</tr>
<tr>
<td>• PHS 550: Principles of Epidemiology (3)</td>
<td></td>
</tr>
<tr>
<td>• PHS 571: Health Services Organization and Delivery (3) or HPA 520: Introduction to Health Services Organizations and Delivery (3)</td>
<td></td>
</tr>
<tr>
<td>• PHS 895A: Master of Public Health Internship (3)</td>
<td></td>
</tr>
<tr>
<td>• PHS 894: Capstone Experience (3)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Elective credits</th>
<th>18 credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total credits</td>
<td>42 credits</td>
</tr>
</tbody>
</table>

While PHS 542 will no longer be required, it will be offered as an elective course for those students who are interested in environmental health.
B. Add PHS 806: Public Health Ethics to Dr.P.H. Core Requirements

We propose to add PHS 806: Public Health Ethics (3 credits) as a core requirement and remove the option for students to take BIOET 501, BIOET 502, BUS 515, HPA 836, PHIL 432, HLS 803, BUSAD 551, HLTHL 961, or CAS 426W to satisfy the program’s ethics requirement. PHS 806 is a new course developed for the Dr.P.H. program, and will be taught in the Department of Public Health Sciences. PHS 806 has been submitted in the Curriculum Review and Consultation System (CRCS). A description of PHS 806: Public Health Ethics is as follows:

Public Health Ethics will familiarize students with the tenets that apply to health care delivery, experimentation, research, and human behavior as guided by principles developed over time to apply to government oversight of public health. Many of these principles are the results of specific cases or phenomena that have arisen over time and led to social interventions as a result. The course will look at several seminal events and the ethical principles derived from them. In many cases, principles are still being debated and the lines between ethical and unethical behavior still being negotiated. The differences between morals, ethics, and laws will be examined. The consequences of violating them will be explored. As scientific research grows in size and complexity, new principles will be needed. Students will also demonstrate a sound sense of scholarship and research integrity (SARI) by participating in ongoing discussions about Responsible Conduct of Research (RCR). Major topics will include moral reasoning, ethical decision-making frameworks, research integrity, and numerous case studies that highlight the interplay between ethics, law, and public health issues past, present, and future. The aims of this course include the education of public health leaders in applying ethical principles to public health issues, and enhancing decision making skills and capabilities that are necessary for creating an ethical approach to public health practice and research.

C. Reduce the number of foundational courses for Dr.P.H. applicants without an M.P.H. degree

We propose to remove PHS 542: Environmental Health (3 credits) as a foundational course for those Dr.P.H. applicants without an M.P.H. degree. This would reduce the foundational courses for those Dr.P.H. applicants without an M.P.H. degree from 15 credits to 12 credits. The resultant foundational course requirements for these applicants would be as follows:

<table>
<thead>
<tr>
<th>Master of Public Health (M.P.H.) Foundational Courses*</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHS 504: Behavioral Health Intervention Strategies</td>
<td>3</td>
</tr>
<tr>
<td>PHS 520: Principles of Biostatistics</td>
<td>3</td>
</tr>
<tr>
<td>PHS 550: Principles of Epidemiology</td>
<td>3</td>
</tr>
<tr>
<td>PHS 571: Introduction to Health Services Organization &amp; Delivery</td>
<td>3</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>12</strong></td>
</tr>
</tbody>
</table>

*Some courses may be waived based on masters-level coursework. Students must petition the head of the graduate program to obtain a waiver in advance.
IV. Proposed Graduate Bulletin

Public Health (PH)

Program Home Page
VERNON M. CHINCHILLI, Chair of the Department of Public Health Sciences
College of Medicine, Penn State Milton S. Hershey Medical Center
Hershey, PA 17033
717-531-7178

Degrees Conferred:
M.P.H., Dr.P.H.
Joint M.D./M.P.H.

The Graduate Faculty

The Program

The Master of Public Health (M.P.H.) in Public Health program is a professional degree program that builds knowledge and skills in the areas of systems thinking, evidence-based public health, leadership, program planning and management, public health and health systems, communication, and interprofessional practice. In addition, the M.P.H. in Public Health program advances expertise in community and behavioral health, epidemiology and biostatistics, and health systems organization and policy. The M.P.H. degree leads to careers in a wide variety of fields and settings, including local, state, and federal government agencies; health care settings; health insurance industry; health services networks; nonprofits; and the pharmaceutical industry.

The Doctor of Public Health (Dr.P.H.) in Public Health program is a professional degree program that provides advanced public health education and training to prepare its graduates for evidence-based practice and leadership in the application of translational science and implementation research findings. It allows graduates to pursue career opportunities in the federal, state, and local government, as well as in the non-profit, academic, and private sectors. Educationally it places an emphasis on discovery, teaching, integration, and application with a primary purpose of bridging research and practice to protect and improve the public’s health. The Dr.P.H. builds on Master of Public Health (M.P.H.) competency domains and, as a professional degree, integrates public health practice and project-based learning with local, state, and federal networks to enrich learning in health policy and program development and implementation. Dr.P.H. program of study includes course work, an advanced field experience, and integrative doctoral research and provides an opportunity for further specialization within a specified cognate.

Admission Requirements

Applicants apply for admission to the program via the Graduate School application for admission. Requirements listed here are in addition to general Graduate Council requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.
M.P.H. Admission Requirements

Admission to the Penn State M.P.H. Program is granted jointly by the M.P.H. Program and the Graduate School at Penn State.

For admission to the M.P.H. Program, applicants must submit:
- Completed online Graduate School application with nonrefundable application fee
- Resume or curriculum vitae
- Statement of purpose
- Two letters of recommendation
- **Official transcripts from all post-secondary institutions attended**
- Official scores from one of the following standardized tests taken within the past five years; Graduate Record Examination (GRE), Medical College Admission Test (MCAT), or Law School Admission Test (LSAT)

Standardized Test Requirement Waiver 1: This requirement is waived for applicants who have an advanced degree beyond the baccalaureate.

Standardized Test Requirement Waiver 2: This requirement may be waived at the discretion of the program for applicants who, prior to submitting the application for admission, have successfully completed (with a grade of B or better in each course):
- At least one 3-credit graduate-level course in biostatistics; AND
- At least one 3-credit graduate-level course in epidemiology; AND
- At least one 3-credit graduate-level course in the social and behavioral sciences or health services administration core areas of public health

Dr.P.H. Admission Requirements

- Completed online Graduate School application with nonrefundable application fee
- Three recommenders to provide letters of academic and professional reference
- Statement of purpose
  - Describe why you want to pursue a Dr.P.H., how you plan to use your education and training, the needs and/or challenges you perceive as important in your field of study, and any personal qualities, characteristics, skills and experiences you believe will enable you to be successful in public health
- **Official Graduate Record Examination (GRE) scores taken within the past five years**
- **Official transcripts from all post-secondary institutions attended**
- CV or resume

M.P.H. Degree Requirements

Requirements listed here are in addition to requirements stated in the DEGREE REQUIREMENTS section of the Graduate Bulletin.

M.P.H. students must complete a total of 42 credits of graduate level course work, the majority of which are 500 level courses, specifically:
- 24 credits in prescribed courses, including:
  - 18 credits of core classroom-based courses
The capstone course (PHS 894) provides the students with the knowledge and skills to design, carry out, and present a scholarly public health project based upon competencies gained in previous courses. Topics include defining a scholarly project, selecting a topic and project type, describing the problem, reviewing the literature, identifying project methodology, presenting project results, ethics and scholarly work, writing and critiquing scholarly work, and creating and delivering a poster presentation.

**Prescribed Courses:** 24 credits

PHS 501(3), PHS 504(3) or BB H 504(3), PHS 520(3), PHS 536(3), PHS 550(3), PHS 571(3) or H P A 520(3), PHS 894(3), PHS 895A(3).

**Additional Courses:** 18 credits

The 18 credits of electives may be selected from a list of approved courses that is maintained by the graduate program office. Multiple tracks of specialization are available. Please visit med.psu.edu/mph to learn more about the approved elective courses and available tracks.

**Joint Degree Offering with the Penn State Hershey College of Medicine**

**Degrees Conferred:**

M.D. (Hershey)
M.P.H. (Hershey)

**Joint Degree Program**

The M.P.H. in Public Health program and M.D. Program at Penn State Hershey College of Medicine offer a joint degree program leading to the degrees of Doctor of Medicine (M.D.) and Master of Public Health (M.P.H.).

**Admissions Requirements**

Admissions requirements for the M.D./M.P.H program are the same as those for the M.D. and M.P.H. in Public Health programs. M.D./M.P.H. students will have to meet the admissions requirements of both programs, and each program will make a separate admissions decision. The admission requirements for the Master of Public Health degree are listed above. Admissions requirements and applications for admission for Penn State College of Medicine are available at the M.D. Program section of the Penn State College of Medicine website. Students will first apply and be accepted to the M.D. program at the Penn State College of Medicine. After being accepted to and matriculating at the Penn State M.D. program, M.D. students will be eligible to submit a Penn State Graduate Application for Admission to the M.P.H. in Public Health. M.D. students may submit an application starting their first semester in the M.D. program up through the fall semester of their third year of medical school.
M.D./M.P.H. students who, for whatever reason, withdraw from the M.D. program retain the option of remaining in the M.P.H. in Public Health program to earn the graduate degree.

**M.D./M.P.H. Degree Requirements**

M.D./M.P.H. degree requirements are the same as that of the standalone M.P.H. degree program. 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](#) section of the Penn State College of Medicine website. Degree requirements for the M.P.H. degree are listed above.

**Double-Counting of Courses**

Sixteen credits of M.D. course work may be double-counted toward the M.P.H. degree.

**Advising of Students**

All students in the M.D./M.P.H. program will have two academic advisers, one in the M.P.H. degree program and one in the M.D. program.

**Dr.P.H. Degree Requirements**

Requirements listed here are in addition to requirements stated in the [DEGREE REQUIREMENTS](#) section of the [Graduate Bulletin](#).

Dr.P.H. students must complete a minimum of 60 credits of graduate-level course work beyond a master’s degree, the majority of which are 500-level and 800-level courses, specifically:

- 24 credits in prescribed, core classroom-based courses
- 21 credits in elective courses
  - 9 credits of track elective courses
  - 12 credits of general (cognate) elective courses
- 15 additional credits
  - 6 credits of Advanced Field Experience
  - 9 credits of Integrative Doctoral Research

**Prescribed Courses:** 24 credits

PHS 575(3); PHS 576(3); PHS 577(3); PHS 554(3); PHS 555(3); ADTED 550(3); PHS 806(3); and PHS 892(3)

**Elective Courses:** 21 credits

The remaining credits may be selected from a list of approved courses that is maintained by the graduate program office. Multiple tracks of specialization are available. Please visit [med.psu.edu/drph](http://med.psu.edu/drph) to learn more about the approved elective courses and available tracks.

**Additional credits:** 15 credits

PHS 895B (6), PHS 896A (6), PHS 896B (3)
Dr.P.H. students must meet Penn State doctoral degree requirements as outlined in the Graduate Bulletin, including candidacy examination, English competencies, and doctoral committee composition. Dr.P.H. students must also meet additional Dr.P.H.-specific requirements.

**Dr.P.H. --Additional Specific Requirements**

The Dr.P.H. degree is conferred in recognition of advanced preparation of a high order for work in the profession of education as evidenced by:

1. Satisfactory completion of a prescribed period of study;
2. Ability to apply translational science and implementation research findings in evidence-based public health practice;
3. Successful performance of candidacy and comprehensive examinations, covering public health core areas of study and a field of specialization; and
4. The preparation and acceptance of integrative doctoral research.

**Residency requirements--**The Doctor of Public Health requires 24 core credits to be taken in residence as a registered student engaged in academic work at the Hershey and Harrisburg campuses.

**Additional Course Requirements for Applicants without a Master of Public Health**

Applicants must have a graduate (e.g. master’s) or advanced professional (e.g., M.D.) degree. Applicants without a Master of Public Health or related degree are required to take core courses to ensure a firm foundation in discipline-specific M.P.H. competency domains. These foundation courses include: PHS 504 (3), PHS 520 (3), PHS 550 (3), and PHS 571 (3).

For applicants entering the program without a Master of Public Health, the minimum credits required for the Dr.P.H. degree will include these 12 credits of foundation courses, for a minimum total of 72. Some or all of the foundation courses may be waived based on previous graduate-level course work, in which case the total credits required for the degree may be reduced in an equivalent manner, down to the base minimum of 60 credits. Students must petition the head of the graduate program to obtain a waiver for the foundation courses, and students’ transcripts will be reviewed to assess their eligibility for a waiver.

**Comprehensive Examination--**Upon completing all core and most cognate course work, Dr.P.H. students will take comprehensive exams to ensure they meet Dr.P.H. core and track program competencies. Comprehensive exams will be overseen and evaluated by students’ doctoral committee.

**Integrative Doctoral Research--**Dr.P.H. students will be required to complete two major components for their Dr.P.H. integrative experience: two publishable-quality manuscripts and a doctoral portfolio. With guidance from their doctoral adviser and doctoral committee, students will develop two manuscripts that comprehensively address, generate, and/or interpret and evaluate knowledge applicable to public health practice. Manuscripts are encouraged to be of an applied nature and must demonstrate students’ abilities to conduct independent research on a contemporary public health issue. Students will demonstrate the application of advanced public health practice skills and knowledge in the design and execution of a scholarly project, the analysis and interpretation of the findings, and the application of the new knowledge to advance public health practice. This work should contribute to the evidence base of public health practice, be of publishable quality, and demonstrate critical thinking and rigorous analytic strategies.
Throughout their doctoral program, students will develop a doctoral portfolio that will document how Dr.P.H. courses, advanced field experience, other experiential learning, and self-knowledge has informed their leadership style and approach to integrating evidence-based research into public health practice. Components of the portfolio may include, but are not limited to, research (e.g., publications, conference presentations), teaching (academic and non-academic, community-based teaching), and field and other service learning experiences. Portfolios will require reflection on in-class and out-of-class experiences and demonstrate students’ broad public health knowledge, specialized knowledge, translation of this knowledge into evidence-based public health practice, and leadership style. Integrative Doctoral Research will demonstrate the following competencies: data and analysis, communication, systems thinking, leadership, critical thinking, and problem solving. Written and oral presentation of this work will be required.

**Student Aid**
Refer to the Student Aid section of the Graduate Bulletin. Students in this program are not eligible for graduate assistantships.

**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.

**PUBLIC HEALTH (PH) course list**
V. Proposed Graduate Bulletin in Track Changes

Public Health (PH)

Program Home Page

VERNON M. CHINCHILLI, Chair of the Department of Public Health Sciences
College of Medicine, Penn State Milton S. Hershey Medical Center
Hershey, PA 17033
717-531-7178

Degrees Conferred:

M.P.H., Dr.P.H.
Integrated B.S. in Biobehavioral Health and Master of Public Health (M.P.H.)
Joint M.D./M.P.H.

The Graduate Faculty

The Program

The Master of Public Health (M.P.H.) in Public Health program is a professional degree program that builds knowledge and skills in the areas of systems thinking, evidence-based public health, leadership, program planning and management, public health and health systems, communication, and interprofessional practices in the five core areas of public health: biostatistics, environmental health sciences, epidemiology, health services administration, and social and behavioral sciences. In addition, the M.P.H. in Public Health program advances expertise in community and behavioral health, epidemiology and biostatistics, and health systems organization and policy. The M.P.H. degree leads to careers in a wide variety of fields and settings, including local, state, and federal government agencies; health care settings; health insurance industry; health services networks; nonprofits; and the pharmaceutical industry.

The Doctor of Public Health (Dr.P.H.) in Public Health program is a professional degree program that provides advanced public health education and training to prepare its graduates for evidence-based practice and leadership in the application of translational science and implementation research findings. It allows graduates to pursue career opportunities in the federal, state, and local government, as well as in the non-profit, academic, and private sectors. Educationally it places an emphasis on discovery, teaching, integration, and application with a primary purpose of bridging research and practice to protect and improve the public’s health. The Dr.P.H. builds on Master of Public Health (M.P.H.) competency domains and, as a professional degree, integrates public health practice and project-based learning with local, state, and federal networks to enrich learning in health policy and program development and implementation. Dr.P.H. program of study includes course work, an advanced field experience, and integrative doctoral research and provides an opportunity for further specialization within a specified cognate.

Admission Requirements
Applicants apply for admission to the program via the Graduate School application for admission. Requirements listed here are in addition to general Graduate Council requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.

M.P.H. Admission Requirements

Admission to the Penn State M.P.H. Program is granted jointly by the M.P.H. Program and the Graduate School at Penn State.

For admission to the M.P.H. Program, applicants must submit:
- Completed online Graduate School application with nonrefundable application fee
- Resume or curriculum vitae
- Statement of purpose
- Two letters of recommendation
- Official transcripts from all post-secondary institutions attended
- Official scores from one of the following standardized tests taken within the past five years; Graduate Record Examination (GRE), Graduate Management Admission Test (GMAT), Medical College Admission Test (MCAT), or Law School Admission Test (LSAT)

Standardized Test Requirement Waiver 1: This requirement is waived for applicants who have an advanced degree beyond the baccalaureate.

Standardized Test Requirement Waiver 2: This requirement may be waived at the discretion of the program for applicants who, prior to submitting the application for admission, have successfully completed (with a grade of B or better in each course):
- At least one 3-credit graduate-level course in biostatistics; AND
- At least one 3-credit graduate-level course in epidemiology; AND
- At least one 3-credit graduate-level course in the social and behavioral sciences or health services administration core areas of public health

Dr.P.H. Admission Requirements

- Completed online Graduate School application with nonrefundable application fee
- Three recommenders to provide letters of academic and professional reference
- Statement of purpose
  - Describe why you want to pursue a Dr.P.H., how you plan to use your education and training, the needs and/or challenges you perceive as important in your field of study, and any personal qualities, characteristics, skills and experiences you believe will enable you to be successful in public health
- Official Graduate Record Examination (GRE) scores taken within the past five years
- Official transcripts from all post-secondary institutions attended
- CV or resume

M.P.H. Degree Requirements

Requirements listed here are in addition to requirements stated in the DEGREE REQUIREMENTS section of the Graduate Bulletin.
M.P.H. students must complete a total of 45-42 credits of graduate level course work, the majority of which are 500 level courses, specifically:

- **27-24** credits in prescribed courses, including:
  - 21-18 credits of core classroom-based courses
  - 3 credit practicum experience
  - 3 credit capstone

- **18 credits** in elective courses

The capstone course (PHS 894) provides the students with the knowledge and skills to design, carry out, and present a scholarly public health project based upon competencies gained in previous courses. Topics include defining a scholarly project, selecting a topic and project type, describing the problem, reviewing the literature, identifying project methodology, presenting project results, ethics and scholarly work, writing and critiquing scholarly work, and creating and delivering a poster presentation.

### Prescribed Courses: 27-24 credits

- PHS 501(3), PHS 504(3) or BB H 504(3), PHS 520(3), PHS 536(3), PHS 542(3), PHS 550(3), PHS 571(3) or HPA 520(3), PHS 894(3), PHS 895A(3).

### Additional Courses: 18 credits

The 18 credits of electives may be selected from a list of approved courses that is maintained by the graduate program office. Multiple tracks of specialization are available. Please visit [www.mphprogram.psu.edumed.psu.edu/mph](http://www.mphprogram.psu.edumed.psu.edu/mph) to learn more about the approved elective courses and available tracks.

### Joint Degree Offering with the Penn State Hershey College of Medicine

#### Degrees Conferred:

- M.D. (Hershey)
- M.P.H. (Hershey)

#### Joint Degree Program

The M.P.H. in Public Health program and M.D. Program at Penn State Hershey College of Medicine offer a joint degree program leading to the degrees of Doctor of Medicine (M.D.) and Master of Public Health (M.P.H.).

#### Admissions Requirements

Admissions requirements for the M.D./M.P.H program are the same as those for the M.D. and M.P.H. in Public Health programs. M.D./M.P.H. students will have to meet the admissions requirements of both programs, and each program will make a separate admissions decision. The admissions requirements for the M.P.H. degree are listed above. Admissions requirements and applications for admission for the Penn State College Medicine are available at the [M.D. Program section of the Penn State College of Medicine website](http://www.mpphprogram.psu.edumed.psu.edu/mph). Students will first apply and be accepted to the M.D. program at the Penn State College of Medicine and then be considered for admission to the M.P.H. program.
College of Medicine. After being accepted to and matriculating at the Penn State M.D. program, M.D. students will be eligible to submit a Penn State Graduate Application for Admission to the M.P.H. in Public Health. M.D. students may submit an application starting their first semester in the M.D. program up through the fall semester of their third year of medical school.

M.D./M.P.H. students who, for whatever reason, withdraw from the M.D. program retain the option of remaining in the M.P.H. in Public Health program to earn the graduate degree.

**M.D./M.P.H. Degree Requirements**

M.D./M.P.H. degree requirements are the same as that of the standalone M.P.H. degree program. 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 section of the Penn State College of Medicine website. Degree requirements for the M.P.H. degree are listed above.

**Double-Counting of Courses**

Eighteen-Sixteen credits of M.D. course work may be double-counted toward the M.P.H. degree.

**Advising of Students**

All students in the M.D./M.P.H. program will have two academic advisers, one in the M.P.H. degree program and one in the M.D. program.

**Integrated Undergraduate-Graduate (IUG) Degree Program with the Penn State College of Health and Human Development, Department of Biobehavioral Health**

The M.P.H. in Public Health program at Penn State Hershey College of Medicine and the B.S. in Biobehavioral Health program at University Park offer an Integrated Undergraduate-Graduate (IUG) degree program leading to the degrees of Bachelor of Science (B.S.) and Master of Public Health (M.P.H.).

**Admissions Requirements**

Students must apply to and meet the admissions requirements of the Graduate School, as well as the graduate program in which they intend to receive their master’s degree. Admission to the IUG and the M.P.H. degree program is granted jointly by the MPH Program and the Graduate School at Penn State. The requirements presented here are in addition to the Graduate School’s requirements for admission. To be eligible to apply to the IUG program, applicants must meet the following requirements:

<table>
<thead>
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<th>Requirements</th>
<th>Guidelines</th>
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| GPA          | • Cumulative GPA: 3.25 or greater  
|              | • GPA in BB H major courses: 3.0 or greater |
| Education    | • Enrollment in the B.S. in BB H degree program  
|              | • Completion of the following courses: BB H 101, BB H 311 or BB H 316, STAT 200 or STAT 250, PSYCH 100, BIOL 110, BIOL 141 |
The M.P.H. in Public Health program will continue to monitor the academic performance of undergraduate students who apply and are admitted to the IUG program. If students fall below the GPA requirements during the undergraduate portion of the IUG plan of study, they may be put on probation or terminated from the IUG program altogether.

IUG application requirements include the following:
- Completed online Penn State Graduate School application with nonrefundable application fee
- Resume or curriculum vitae
- Statement of purpose
- Two letters of recommendation, including one from the student’s undergraduate academic adviser that proves the academic adviser has worked with the student to develop a draft IUG plan of study
- Official transcripts from all post-secondary institutions attended
- Preliminary draft plan of study. The plan should cover the entire time period of the integrated program, and it should be reviewed periodically with an adviser as the student advances through the program.

Students may begin applying to the IUG in the spring semester of their sophomore year, but must apply no later than the middle of the spring semester of their junior year of the B.S. in Biobehavioral Health degree program. Students must be admitted to the program prior to taking the first course they intend to count towards the graduate degree.

B.S./M.P.H. Degree Requirements

B.S./M.P.H. degree requirements are the same as that of the standalone M.P.H. degree program. If students accepted into the IUG program are unable to complete the M.P.H. degree, they are still eligible to receive their undergraduate degree if all the undergraduate degree requirements have been satisfied.

Double-Counting of Courses

Up to 12 credits of M.P.H. degree course work will double count towards the B.S. in Biobehavioral Health degree requirements. The following courses will double count towards the B.S. and the M.P.H. degree requirements: PHS 504 (3) or BB H 504 (3); PHS 520 (3) or STAT 500 (3); PHS 550 (3) or STAT 507 (3); and PHS 571 (3) or H P A 520 (3).

Advising of Students

The M.P.H. in Public Health program will assign IUG students with an academic adviser. This adviser is in addition to the one assigned to them as undergraduate students enrolled in the B.S. in Biobehavioral Health degree program. The M.P.H. in Public Health adviser will be a faculty member from the Department of Public Health Sciences at the Penn State College of Medicine in Hershey, PA who is a member of the Graduate Faculty. The academic adviser will be assigned upon entry into the M.P.H. degree program. If advisers are on different campuses than their respective students, they will communicate with their students through a combination of videoconferencing (via Skype or other mechanism), phone, email, and in-person meetings.
Dr.P.H. Degree Requirements

Requirements listed here are in addition to requirements stated in the DEGREE REQUIREMENTS section of the Graduate Bulletin.

Dr.P.H. students must complete a minimum of 60 credits of graduate-level course work beyond a master’s degree, the majority of which are 500-level and 800-level courses, specifically:

- 24 credits in prescribed, core classroom-based courses
- 21 credits in elective courses
  - 9 credits of track elective courses
  - 12 credits of general (cognate) elective courses
- 15 additional credits
  - 6 credits of Advanced Field Experience
  - 9 credits of Integrative Doctoral Research

Prescribed Courses: 24 credits
PHS 575(3); PHS 576(3); PHS 577(3); PHS 554(3); PHS 555(3); ADTED 550(3); PHS 806(3); and BIOET 501(3), BIOET 502(3), BUS 515(2), H P A 836(3), HLS 803(3), PHIL 432(3), CAS 426W(3), HLTHL 961(3), or BUSAD 551(3); PHS 892(3)

Elective Courses: 21 credits
The remaining credits may be selected from a list of approved courses that is maintained by the graduate program office. Multiple tracks of specialization are available. Please visit www.med.psu.edu/mphmed.psu.edu/drph to learn more about the approved elective courses and available tracks.

Additional credits: 15 credits
PHS 895B (6), PHS 896A (6), PHS 896B (3)

Dr.P.H. students must meet Penn State doctoral degree requirements as outlined in the Graduate Bulletin, including candidacy examination, and English competencies, and doctoral committee composition. Dr.P.H. students must also meet additional Dr.P.H.-specific requirements.

Dr.P.H. --Additional Specific Requirements
The Dr.P.H. degree is conferred in recognition of advanced preparation of a high order for work in the profession of education as evidenced by:

1. Satisfactory completion of a prescribed period of study;
2. Ability to apply translational science and implementation research findings in evidence-based public health practice;
3. Successful performance of candidacy and comprehensive examinations, covering public health core areas of study and a field of specialization; and
4. The preparation and acceptance of integrative doctoral research.

Residency requirements--The Doctor of Public Health requires 24 core credits to be taken in residence as a registered student engaged in academic work at the Hershey and Harrisburg campuses.

Additional Course Requirements for Applicants without a Master of Public Health
Applicants must have a graduate (e.g. master’s) or advanced professional (e.g., M.D.) degree. Applicants without a Master of Public Health or related degree are required to take core courses to ensure a firm foundation in discipline-specific M.P.H. competency domains. These foundation courses include: PHS 504 (3), PHS 520 (3), PHS 542 (3), PHS 550 (3), and PHS 571 (3).

For applicants entering the program without a Master of Public Health, the minimum credits required for the Dr.P.H. degree will include these 15-12 credits of foundation courses, for a minimum total of 7572. Some or all of the foundation courses may be waived based on previous graduate-level course work, in which case the total credits required for the degree may be reduced in an equivalent manner, down to the base minimum of 60 credits. Students must petition the head of the graduate program to obtain a waiver for the foundation courses, and students’ transcripts will be reviewed to assess their eligibility for a waiver.

Comprehensive Examination—Upon completing all core and most cognate course work, Dr.P.H. students will take comprehensive exams to ensure they meet Dr.P.H. core and track program competencies. Comprehensive exams will be overseen and evaluated by students’ doctoral committee.

Integrative Doctoral Research—Dr.P.H. students will be required to complete two major components for their Dr.P.H. integrative experience: two publishable-quality manuscripts and a doctoral portfolio. With guidance from their doctoral adviser and doctoral committee, students will develop two manuscripts that comprehensively address, generate, and/or interpret and evaluate knowledge applicable to public health practice. Manuscripts are encouraged to be of an applied nature and must demonstrate students’ abilities to conduct independent research on a contemporary public health issue. Students will demonstrate the application of advanced public health practice skills and knowledge in the design and execution of a scholarly project, the analysis and interpretation of the findings, and the application of the new knowledge to advance public health practice. This work should contribute to the evidence base of public health practice, be of publishable quality, and demonstrate critical thinking and rigorous analytic strategies.

Throughout their doctoral program, students will develop a doctoral portfolio that will document how Dr.P.H. courses, advanced field experience, other experiential learning, and self-knowledge has informed their leadership style and approach to integrating evidence-based research into public health practice. Components of the portfolio may include, but are not limited to, research (e.g., publications, conference presentations), teaching (academic and non-academic, community-based teaching), and field and other service learning experiences. Portfolios will require reflection on in-class and out-of-class experiences and demonstrate students’ broad public health knowledge, specialized knowledge, translation of this knowledge into evidence-based public health practice, and leadership style. Integrative Doctoral Research will demonstrate the following competencies: data and analysis, communication, systems thinking, leadership, critical thinking, and problem solving. Written and oral presentation of this work will be required.

Student Aid
Refer to the Student Aid section of the Graduate Bulletin. Students in this program are not eligible for graduate assistantships.

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.

PUBLIC HEALTH (PH) course list
VI. Letters of Support

(1) Vernon M. Chinchilli, PhD
(2) Thomas Gould, PhD
(3) Marianne Hillemeier, PhD
(4) Hengameh Hosseini, PhD
(5) John Iceland, PhD
(6) David Hunter, PhD
(7) Patria Julnes, PhD
(8) Douglas Kennett, PhD
(9) Raffy R. Luquis, PhD
Vernon M. Chinchilli, PhD
Distinguished Professor and Chair
Department of Public Health Sciences
Penn State College of Medicine
vchinchi@psu.edu
November 09, 2016

The Graduate School
The Pennsylvania State University
University Park, PA 16802

Dear Colleagues:

The purpose of this letter is to express my enthusiastic support for the three proposed changes in the public health graduate programs offered by the Department of Public Health Sciences. The three proposed changes are as follows:

- reduce the M.P.H. in Public Health from 45 credits to 42 credits
- add PHS 806: Public Health Ethics to the core requirements of the Dr.P.H. degree program
- reduce the number of foundational courses for Dr. P.H. applicants without a Master of Public Health (M.P.H.) degree

The Council on Education in Public Health (CEPH), the national accrediting body for schools of public health and public health degree programs, recently revised the educational objectives and initiatives for public health programs. In turn, this is causing the Department to modify its public health programs and pursue the changes that are described in the proposal.

As the Chair of the Department of Public Health Sciences, and I am very pleased with, and proud of, our M.P.H. and Dr.P.H. programs. I fully expect that our programs will continue to grow and be successful. The proposed changes will enhance our programs and keep them competitive with other public health programs in the Northeast US. Therefore, I strongly urge you to approve of the proposal.

Sincerely,

Vernon M. Chinchilli

Vernon M. Chinchilli, PhD
Dear Farah,

BBH supports the proposed changes to the MPH program.

Sincerely,

Tom

Thomas Gould, PhD
Jean Phillips Shibley Professor of Biobehavioral Health
Department Head, Department of Biobehavioral Health
Representing the graduate program in Biobehavioral Health
Hi Farah,

I agree with the changes--thanks for consulting me.

Best wishes,
Marianne

Marianne Hillemeier, PhD
Professor of Health Policy and Administration and Demography
Department Head, Department of Health Policy and Administration
Representing graduate programs in Health Policy and Administration
From: HENGAMEH HOSSEINI [mailto:huh19@psu.edu]
Sent: Monday, November 14, 2016 1:08 PM
To: Farah Kauffman
Subject: Re: Request for Support of Program Change Proposal

Dear Farah,

Below you will find my review:

I agree with your proposal that PHS 806 Health Ethics would become a Core requirement and a central component of the Public Health degree program, and one that would emphasize personal, professional, and organizational ethical decision-making and it should be embedded throughout DrPh courses.

I also agree with the reduction of the number of foundational courses for the Doctor of Public Health applicants without a Master of Public Health degree.

Best,

Hengameh

Hengameh Hosseini, Ph.D.
Assistant Professor, Health Administration
Program Coordinator, Certificate Program in Long-term Care
School of Public Affairs
Penn State Harrisburg
Dear Farah,

This proposal looks totally fine to me.

Best wishes,
Dave

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David Hunter, PhD
Professor and Head
Department of Statistics
Penn State University
Phone: (814) 865-1348
Fax: (814) 863-7114
www.stat.psu.edu/~dhunter
Representing graduate programs in Statistics
From: JOHN DAVID ICELAND [mailto:jdi10@psu.edu]
Sent: Wednesday, November 09, 2016 3:39 PM
To: Farah Kauffman
Subject: Re: Request for Support of Program Change Proposal

Dear Farah,

I have no objections to the proposed changes. Good luck moving them forward.

Best,
John

John Iceland, PhD
Professor and Head
Department of Sociology and Criminology
Representing graduate program in Sociology
From: PATRIA D DE LANCER JULNES [mailto:pdd10@psu.edu]
Sent: Wednesday, November 16, 2016 8:09 PM
To: Farah Kauffman
Subject: Re: Request for Support of Program Change Proposal

Good evening Mr. Kauffman,
I have reviewed your proposal and fully support it. I believe the rationale you provided support all three changes.
Sincerely,

Dr. Patria Julnes

Patria de Lancer Julnes, Ph.D.
Director, School of Public Affairs
Penn State Harrisburg
Representing graduate programs in Health Administration and Public Administration
Many thanks Farah. I approve and hope that Anthropology can become more integrated into your program moving in to the future. We are currently discussing moving more into the medical/health direction.

cheers,

Doug

Douglas Kennett, PhD
Professor of Anthropology
Department Head, Department of Anthropology
Representing graduate program in Anthropology
Hello Farah,  

I have reviewed the proposed changes to the MPH, Dr.PH, and foundation courses; and given the rationale for these changes, I fully support these changes.

Sincerely,

Dr. Raffy Luquis  
Raffy Luquis, PhD  
Associate Professor of Health Education  
Program Coordinator, Master of Education in Health Education