

# University Bulletin

## Undergraduate Degree Programs

### Primary Navigation

### Science, Eberly College

On March 17, 1989, Penn State's Board of Trustees renamed the College of Science to honor one of its most generous benefactors--the Eberly Family Charitable Trust of Uniontown. The generosity of the Eberly family has enabled the college to attract and retain outstanding faculty members who work at the cutting edge of their fields and who create opportunities for study and research that attract topflight graduate and undergraduate students.

The EBERLY COLLEGE OF SCIENCE provides instruction and research opportunities in the biological, mathematical, and physical sciences for students in this and other colleges in the University. The college offers ten majors that lead to the B.S. degree and one (Science) that leads to either the B.S. or B.A. degree. Various options are available within many of the majors. Many graduates continue their education in graduate or professional schools while others choose from a variety of careers in industry, government, or education.

**UNDERGRADUATE INSTRUCTION** -- In the first four semesters, basic biological and physical science, mathematics, and English are emphasized. Those who show an aptitude for scientific or mathematical work at the end of these four semesters continue in the major of their choice. To be eligible for entrance to a major in this college, the degree candidate must meet entrance-to-major requirements of the University, of the college, and of the program area.

#### **ENTRANCE-TO-COLLEGE REQUIREMENTS**

In order to be eligible for entrance to the Eberly College of Science in premajor (SCIEN) status, a student must have:

- 1) Attained at least a 2.00 cumulative grade-point average
- 2) Completed MATH 140 with a grade of C or better

A student who meets the above requirements, but who has not demonstrated a comparable level of scholarship in other mathematics and science courses applicable to the programs of the college, is strongly encouraged to contact the Eberly College of Science Academic Advising Center or other appropriate advising personnel for assistance.

#### **ENTRANCE-TO-MAJOR REQUIREMENTS**

In order to be eligible for entrance to a major in the Eberly College of Science, a student must have satisfied all additional academic requirements as specified by the major:

<http://www.science.psu.edu/advising/majorrequirements/entrancetomajorrequirements.html>

#### **CONTINUING AND DISTANCE EDUCATION**

Activities in Continuing and Distance Education include class and online instruction in credit and noncredit courses and informal instruction.

**CLASS INSTRUCTION**--Instruction in the sciences is offered upon request, provided suitable facilities and faculty are available. Some courses carry college credit and are open only to qualified students; other courses are noncredit and are designed for adults interested in vocational or cultural self-improvement.

**ONLINE COURSE**--College-credit courses in the physical, biological, and mathematical sciences are available through World Campus.

**INFORMAL INSTRUCTION**--These programs are designed to fit the needs of individuals and groups interested in some special phase of adult education, new developments in the field, or professional and industrial applications of new scientific discoveries. Tailored specifically to meet the needs and interests of the groups to be served, the programs are developed in conjunction with the groups themselves.

#### **SCIENCE CAREER AND INTERNATIONAL EDUCATION**

The Eberly College of Science Career and International Education office coordinates a number of domestic

and international educational opportunities for science students.

First-year and sophomore students can participate in the Externship/Job Shadowing Program, which is not credit-bearing, but matches students with a science professional to introduce them to career fields of possible future interest.

Sophomore, junior, and senior students are able to gain major-related work experience while also earning academic credit (SC 295, 395, 495) through their participation in the Cooperative Education Program, or if they have identified a summer internship opportunity through their own personal networks, they can earn academic credit (SC 294, 494) for the experience pending departmental review and approval.

Students at all levels and in all majors will find a variety of academic study abroad opportunities, from faculty-led courses that include a short-term international experience to a full academic year of study at a science partner institution to earn the International Science Certificate. Early planning and careful coordination with academic advisers is strongly encouraged.

For more information about career and international education options for science students, please visit: <http://cie.science.psu.edu>

## **RECOMMENDED ACADEMIC PLANS**

Recommended Academic Plans provide, in table form, the courses students might schedule semester by semester as they pursue a specific undergraduate degree. Each college or campus maintains Recommended Academic Plans for its own majors/degree programs. Links to these plans are on the Division of Undergraduate Studies website at: <http://www.dus.psu.edu/semplans.htm>. Questions concerning the Recommended Academic Plans should be directed to the college or campus involved or the Division of Undergraduate Studies.

## **EBERLY COLLEGE OF SCIENCE**

DOUGLAS R. CAVENER, *Dean*

MARY BETH WILLIAMS, *Senior Associate Dean for Undergraduate Education*

TERESA DAVIS, *Associate Dean for Administration*

CHARLES FISHER, *Associate Dean for Graduate Education*

ANDREW STEPHENSON, *Associate Dean for Research and Innovation*

## **COLLEGE ORGANIZATION**

Astronomy and Astrophysics -- DONALD SCHNEIDER, *Head*

Biochemistry and Molecular Biology -- SCOTT SELLECK, *Head*

Biology -- TRACY LANGKILDE, *Acting Head*

Chemistry -- THOMAS MALLOUK, *Head*

Forensic Science -- WAYNE MOOREHEAD, *Director*

Mathematics -- YUXI ZHENG, *Head*

Physics -- NITIN SAMARTH, *Head*

Premedicine -- RONALD MARKLE, *Director*

Statistics -- DAVID HUNTER, *Head*

## Baccalaureate Degrees

### Astronomy and Astrophysics

University Park, Eberly College of Science (ASTRO)

PROFESSOR DONALD P. SCHNEIDER, *Head*

Astronomy involves the study of the properties, physical nature and origins of the planets, stars, galaxies and universe as a whole. It involves development of instrumentation, observations of celestial objects with ground- and space-based telescopes, and interpretation of findings using the mathematical laws of physics such as gravity, electromagnetism and quantum mechanics. The undergraduate major provides a strong and broad foundation in mathematics, physical science and computation as well as a detailed understanding of modern astronomy. Many research opportunities are available to complement the formal classwork. Graduates proceed to advanced degrees in astronomy and other sciences, and into a wide variety of technical professions.

In order to be eligible for entrance to the Astronomy and Astrophysics major, a student must have: 1) Attained at least a 2.00 cumulative grade-point average. 2) Completed ASTRO 291 GN(3), CHEM 110 GN(3), MATH 140 GQ(4), MATH 141 GQ(4), PHYS 211 GN(4), and PHYS 212 GN(4); and earned a grade of C or better in each of these courses.

For the B.S. degree in Astronomy and Astrophysics, a minimum of 125 credits is required.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

**GENERAL EDUCATION:** 45 credits

(18 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)

(See description of General Education in front of *Bulletin*.)

**FIRST-YEAR SEMINAR:**

(Included in REQUIREMENTS FOR THE MAJOR)

**UNITED STATES CULTURES AND INTERNATIONAL CULTURES:**

(Included in GENERAL EDUCATION course selection)

**WRITING ACROSS THE CURRICULUM:**

(Included in GENERAL EDUCATION course selection or REQUIREMENTS FOR THE MAJOR)

**REQUIREMENTS FOR THE MAJOR:** 98 credits

(This includes 18 credits of General Education courses: 9 credits of GN courses; 6 credits of GQ courses; 3 credits of GWS courses.)

**COMMON REQUIREMENTS FOR THE MAJOR (ALL OPTIONS):** 64 credits

**PRESCRIBED COURSES** (49 credits)

ASTRO 291 GN(3)[1], ASTRO 292 GN(3)[1], ASTRO 320 GN(2), ENGL 202C GWS(3), MATH 230(4), MATH 251(4), PHYS 237(3) (Sem: 3-4)

CHEM 110 GN(3)[1], CHEM 111 GN(1), CHEM 112 GN(3), MATH 140 GQ(4)[1], MATH 141 GQ(4)[1], PHYS 211 GN(4)[1], PHYS 212 GN(4)[1], PHYS 213 GN(2)[1], PHYS 214 GN(2)[1] (Sem: 1-4)

**ADDITIONAL COURSES** (3 credits)

CMPSC 121 GQ(3), CMPSC 201 GQ(3), or CMPSC 202 GQ(3) (Sem: 1-4)

**SUPPORTING COURSES AND RELATED AREAS** (12 credits)

Select 12 credits[1] from 400-level ASTRO courses except ASTRO 401, ASTRO 402, and ASTRO 496 (Sem: 5-8)

**REQUIREMENTS FOR THE OPTION:** 34 credits

**GRADUATE STUDY OPTION:** (34 credits)

**PRESCRIBED COURSES** (10 credits)

PHYS 400(3), PHYS 410(3-4), PHYS 419(3) (Sem: 5-8)

**ADDITIONAL COURSES** (9-10 credits)

Select 3 credits from MATH 405(3), MATH 411(3), or MATH 417(3) (Sem: 3-4)

Select 6-7 credits from PHYS 401(3), PHYS 402(4), PHYS 406(3), PHYS 411(3), PHYS 420(3), PHYS 457(1-3), PHYS 457W(3), PHYS 461(3), and EE 471(3) (Sem: 7-8)

**SUPPORTING COURSES AND RELATED AREAS** (14-15 credits)

Select 3 additional credits from advanced courses in computer science and engineering, mathematics, or statistics (Sem: 5-6)

Select 11-12 credits in consultation with adviser from department list (Sem: 3-8)

**COMPUTER SCIENCE OPTION:** (34 credits)

**PRESCRIBED COURSES** (9 credits)

CMPSC 122(3), CMPSC 221(3) (Sem: 5-6)

CMPSC 451(3) (Sem: 6-8)

**ADDITIONAL COURSES** (9 credits)

Select 3 credits from STAT 318(3), STAT 319(3), STAT 401(3), or STAT 414(3) (Sem: 5-6)

Select 6 credits from CMPEN 271(3), CMPEN 331(3), CMPSC 360(3), or CMPSC 465(3) (Sem: 5-8)

**SUPPORTING COURSES AND RELATED AREAS** (16 credits)

Select 3 additional credits from advanced courses in computer science and engineering (Sem: 5-8)

Select 13 credits in consultation with adviser from department list (Sem: 3-8)

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

Last Revised by the Department: Fall Semester 2014

Blue Sheet Item #: 43-04-101

Review Date: 01/13/2015

UCA Revision #1: 8/14/06

UCA Revision #2: 7/26/07

### Comments

SC

Dept head updated by Publications: 8/2/11

## Biochemistry and Molecular Biology

*Penn State Berks (BMBBL)*

*University Park, Eberly College of Science (B M B)*

Director of Curricular Affairs, Meredith Defelice, *in charge*

Students in this major apply basic principles of chemistry and physics to the study of living cells and their components to explain biology at molecular, genetic, and cellular levels. Students will develop a strong foundation in quantitative and analytical biological sciences, including molecular biology, biochemistry, enzymology, metabolism, cell biology, and molecular genetics. The Biochemistry Option is offered for students who have interests in the structures, properties and functions of macromolecules, and in the quantitative and analytical techniques used to characterize these macromolecules. The Molecular and Cell Biology Option is available to students whose interests relate to the growth, reproduction and differentiation of cells and to signaling processes that occur in multicellular systems that activate and modulate these processes. The curriculum is designed to prepare students for advanced study leading to careers in research, medicine, and education, or to secure employment in biotechnology and health-related industries, including government, academic, and private laboratories.

In order to be eligible for entrance to the Biochemistry and Molecular Biology major, a student must have: 1) attained at least a 2.00 cumulative grade-point average, and 2) completed CHEM 110 GN(3), CHEM 111 GN(1), CHEM 112 GN(3), and MATH 140 GQ(4); and 3) earned a grade of C or better in each of these courses.

For the B.S. degree in Biochemistry and Molecular Biology, a minimum of 125 credits is required.

*Scheduling Recommendation by Semester Standing given like (Sem: 1-2)*

**GENERAL EDUCATION:** 45 credits

(15 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)

(See description of General Education in this bulletin.)

**FIRST-YEAR SEMINAR:**

(Included in REQUIREMENTS FOR THE MAJOR)

**UNITED STATES CULTURES AND INTERNATIONAL CULTURES:**

(Included in GENERAL EDUCATION course selection)

**WRITING ACROSS THE CURRICULUM:**

(Included in REQUIREMENTS FOR THE MAJOR)

**REQUIREMENTS FOR THE MAJOR: 95 credits****[86]**

(This includes 15 credits of General Education courses: 9 credits of GN courses; 6 credits of GQ courses.)  
(To graduate, a grade of C or better is required in 9 credits of any BMB or MICRB 400-level course except BMB 408, BMB 442, BMB 443W, BMB 445W, BMB 446, BMB 448, BMB 488, BMB 496, MICRB 408, MICRB 421, MICRB 422, MICRB 447.)

**COMMON REQUIREMENTS FOR THE MAJOR (ALL OPTIONS): 55 credits**

**PRESCRIBED COURSES** (53 credits)

CHEM 110 GN(3)**[11]**, CHEM 111 GN(1)**[11]**, CHEM 112 GN(3)**[11]**, CHEM 113 GN(1), MATH 140 GQ(4)**[11]**, MATH 141 GQ(4), MICRB 201(3)**[85]**, MICRB 202(2), PSU 016(1) (Sem: 1-2)  
BMB 251(3)**[85]**, BMB 252(3)**[85]**, BMB 442(3), BIOL 322(3), CHEM 210(3), CHEM 212(3), CHEM 213(2), (Sem: 3-4)  
BMB 400(2), BMB 401(3), BMB 402(3), BMB 443(3) (Sem: 5-6)

**ADDITIONAL COURSES** (2 credits)

Select 2 credits from: BMB 445(2) or BMB 448(2) (Sem: 7-8)

**REQUIREMENTS FOR THE OPTION: 40 credits**

**BIOCHEMISTRY OPTION: (40 credits)**

**PRESCRIBED COURSES:** (21 credits)

PHYS 211 GN(4), PHYS 212 GN(4), PHYS 213 GN(2), PHYS 214 GN(2) (Sem: 2-4)  
CHEM 450(3), CHEM 452(3) (Sem: 5-8)  
BMB 474(3) (Sem: 5-8)

**SUPPORTING COURSES AND RELATED AREAS:** (19 credits)

Select 7-9 credits from any 400-level BMB/CHEM/MICRB course or from department list D (additional 400-level courses) with a maximum of 3 credits in BMB 408 and/or MICRB 408 and a maximum of 4 credits in BMB 488 and/or BMB 496 (Sem: 5-8)  
Select 2-3 credits in the mathematical sciences from department list B (Sem 5-8)  
Select 7-10 credits from department list C (Sem: 5-8)

**MOLECULAR AND CELL BIOLOGY OPTION: (40 credits)**

**PRESCRIBED COURSES:** (9 credits)

BMB 430(3), BMB 460(3) (Sem: 5-8)  
MICRB 410(3) (Sem: 5-8)

**ADDITIONAL COURSES:** (11-14 credits)

Select 8 credits from: PHYS 211 GN(4), PHYS 212 GN(4), PHYS 250 GN(4), PHYS 251 GN(4) (Sem: 1-4)  
Select 3-6 credits from: CHEM 450(3), CHEM 452(3); or BMB 428(3) (Sem: 5-8)

**SUPPORTING COURSES AND RELATED AREAS:** (17-20 credits)

Select 5-6 credits from any 400-level BMB/MICRB course or from department list D (additional 400-level courses) with a total maximum of 3 credits in BMB 408 and/or MICRB 408 and a maximum of 4 credits in BMB 488 and/or BMB 496 (Sem:5-8)  
Select 2-3 credits in the mathematical sciences from department list B (Sem: 5-8)  
Select 4-13 credits from department list C (Sem: 5-8)

**[1]** A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

**[85]** To graduate, a grade of C or better is required in two of the following courses: MICRB 201, BMB/MICRB 251, BMB/MICRB 252.

**[86]** To graduate, a grade of C or better is required in 9 credits of any BMB or MICRB 400-level course except BMB 442, BMB 443W, BMB 445W, BMB 446, BMB 448, BMB 488, BMB 496, MICRB 421W, MICRB 422, MICRB 447.

Last Revised by the Department: Fall Semester 2016

Blue Sheet Item #: 45-01-131

Review Date: 08/23/16

UCA Revision #1: 8/2/06

# Biology

Abington College (BIOAB)

Altoona College (BIOAL)

Berks College (BIOBL)

Capital College (BIOCA)

University Park, Eberly College of Science (BIOL)

University College, Penn State Beaver, Penn State Brandywine, Penn State Schuylkill, Penn State Worthington

Scranton, Penn Sate York (BIOCC)

Not all options are available at every campus. Contact the campus you are interested in attending to determine which options are offered.

Carla Hass, Person-In-Charge

The curriculum in Biology is planned for preparation for professions requiring competence in biological science or for gaining an understanding of the world of living things. The professional group includes students who intend to secure advanced degrees through graduate study, students who are interested in work with various governmental agencies or industries having biological responsibilities, and students who want to prepare for careers in medicine or other health-related professions. Students whose interests are not professional select the curriculum because its broad approach can result in an educated view of the structure and function of living things. Achievement of these goals, including a special interest in a particular area of biology, can be met by selecting one of five options offered by the Department of Biology that will lead to the B.S. degree in Biology. The options and their key areas are 1) Plant Biology--morphology, systematics, and physiology of plants and fungi; 2) Ecology--behavior, and population and community biology of plants and animals; 3) General Biology--all aspects of modern biology; 4) Genetics and Developmental Biology--genetics, genetic engineering, and plant and animal development; 5) Neuroscience--development, biochemistry, physiology and aging of the central and peripheral nervous system; 6) Vertebrate Physiology--pre-medicine, pre-dentistry, pharmacology, and animal physiology.

In order to be eligible for entrance to the Biology major, a student must have: 1) attained at least a 2.00 cumulative grade point average; 2) completed BIOL 110 GN(4), CHEM 110 GN(3), MATH 140 GQ(4), and earned a grade of C or better in each of these courses; and 3) completed at least one of the following courses with a grade of C or better: BIOL 220W GN(4), BIOL 230W GN(4), or BIOL 240W GN(4).

## **TO VIEW THE Biology Minor (BIOL)**

For the B.S. degree in Biology, a minimum of 124 credits is required.

*Scheduling Recommendation by Semester Standing given like (Sem: 1-2)*

### **GENERAL EDUCATION: 45 credits**

(15 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)

(See description of General Education in this bulletin.)

### **FIRST-YEAR SEMINAR:**

(Included in GENERAL EDUCATION course selection)

### **UNITED STATES CULTURES AND INTERNATIONAL CULTURES:**

(Included in GENERAL EDUCATION course selection)

### **WRITING ACROSS THE CURRICULUM:**

(Included in REQUIREMENTS FOR THE MAJOR)

### **REQUIREMENTS FOR THE MAJOR: 94 credits**

(This includes 15 credits of General Education courses: 9 credits of GN courses; 6 credits of GQ courses.)

### **COMMON REQUIREMENTS FOR MAJOR (ALL OPTIONS): 40-44 credits**

#### **PRESCRIBED COURSES (32 credits)**

CHEM 110 GN(3)[1], CHEM 111 GN(1), CHEM 112 GN(3)[1], CHEM 113 GN(1), MATH 140 GQ(4)[1], MATH 141 GQ(4) (Sem: 1-2)

BIOL 110 GN(4)[1], BIOL 220W GN(4)[1], BIOL 230W GN(4)[1], BIOL 240W GN(4)[1] (Sem: 1-4)

#### **ADDITIONAL COURSES (8-12 credits)**

PHYS 250 GN(4), PHYS 251 GN(4); or PHYS 211 GN(4), PHYS 212 GN(4), PHYS 213 GN(2), PHYS 214 GN(2) (Sem: 5-6)

**REQUIREMENTS FOR THE OPTION: 50-54 credits**

**ECOLOGY OPTION: (50-54 credits)**

**ADDITIONAL COURSES (30-33 credits)**

CHEM 202(3), CHEM 203(3); or CHEM 210(3), CHEM 212(3), CHEM 213(2) (Sem: 3-4)  
Select 3-4 credits from STAT 200 GQ(4) or STAT 240 GQ(3) or STAT 250 GQ(3) (Sem: 3-4)  
Select 3 credits from STAT 462(3) or STAT 464(3) (Sem: 7-8)

Select a minimum of 18 credits of 400-level biology courses, with at least 3 credits from each of the following groups (courses in Group IV--except BIOL 496, SC 295, SC 395, SC 495--may be used to satisfy requirements in other groups) (Sem: 5-8)

Group I: BIOL 412(3), BIOL 419(3), BIOL 435(3), BIOL 436(3), BIOL 444(3), BIOL 450W(3-5), BIOL 463(3), BIOL 482(3-4), BIOL 499A IL(3)

Group II: BIOL 414(3), BIOL 427(3), BIOL 428(3), BIOL 429(3), BIOL 448(3), BIOL 464(3), BIOL 474(3)

Group III: BIOL 406(3), BIOL 415(3), BIOL 417(4), BIOL 446(3), PPEM 425(4)

Group IV: BIOL 414(3), BIOL 417(4), BIOL 419(3), BIOL 444(3), BIOL 448(3), BIOL 450W(3-5), BIOL 482(3-4), BIOL 496(3), BIOL 499A IL(3), PPEM 425(4), SC 295(1-3), SC 395(1-3), SC 495(1-3) (A maximum of 3 credits of BIOL 496 or 4 credits of SC 295, SC 395, SC 495 may be used to fulfill the 18-credit minimum in the 400-level biology course requirement.)

**SUPPORTING COURSES AND RELATED AREAS (17-24 credits)**

Select 17-24 credits from department list (Sem: 1-8)

**GENERAL BIOLOGY OPTION: (50-54 credits)**

**ADDITIONAL COURSES (27-30 credits)**

CHEM 202(3), CHEM 203(3); or CHEM 210(3), CHEM 212(3), CHEM 213(2) (Sem: 3-4)  
Select 3-4 credits from STAT 200 GQ(4), STAT 240 GQ(3), or STAT 250 GQ(3) (Sem: 3-4)

Select a minimum of 18 credits of 400-level biology courses, with at least 3 credits from each of the following groups (each course may be used to satisfy a requirement in only one group) (Sem: 5-8)

Group I -- BIOL 407(3), BIOL 410(3), BIOL 414(3), BIOL 441(3), BIOL 443(3), BIOL 444(3), BIOL 446(3), BIOL 448(3), BIOL 499A IL(3), HORT 407(3), HORT 440W(3), PPEM 416(2-4), PPATH 425(4)

Group II -- BIOL 405(3), BIOL 411(3), BIOL 414(3), BIOL 417(4), BIOL 420(3), BIOL 421(4), BIOL 425(4), BIOL 427(3), BIOL 428(3), BIOL 438(3), BIOL 443(3), BIOL 460(3), BIOL 474(3)

Group III -- AN SC 442(3), B M B 400(2-3), B M B 450(2), BIOL 404(3), BIOL 405(3), BIOL 407(3), BIOL 410(3), BIOL 411(3), BIOL 416(3), BIOL 422(3), BIOL 426(3), BIOL 428(3), BIOL 430(3), BIOL 432(3), BIOL 439(3), BIOL 443(3), BIOL 448(3), BIOL 460(3), BIOL 499A IL(3), HORT 407(3)

Group IV -- BIOL 406(3), BIOL 412(3), BIOL 414(3), BIOL 415(3), BIOL 417(4), BIOL 419(3), BIOL 428(3), BIOL 429(3), BIOL 435(3), BIOL 436(3), BIOL 444(3) BIOL 446(3), BIOL 448(3), BIOL 450W(3-5), BIOL 463(3), BIOL 464(3), BIOL 474(3), BIOL 499A IL(3),

Group V -- BIOL 404(3), BIOL 406(3), BIOL 409(3), BIOL 411(3), BIOL 413(3), BIOL 416(3), BIOL 421(4), BIOL 426(3), BIOL 430(3), BIOL 432(3), BIOL 437(4), BIOL 443(3), BIOL 446(3), BIOL 460(3), BIOL 469(3), BIOL 470(3), BIOL 472(3), BIOL 479(3)

Group VI -- BIOL 400(1-3), BIOL 407(3), BIOL 414(3), BIOL 417(4), BIOL 419(3), BIOL 421(4), BIOL 437(4), BIOL 439(3), BIOL 444(3), BIOL 448(3), BIOL 450W(3-5), BIOL 461(3), BIOL 471(3), BIOL 473(2), BIOL 496(1-3), PPEM 425(4), SC 295(1-3), SC 395(1-3), SC 495(1-3)

**SUPPORTING COURSES AND RELATED AREAS (20-27 credits)**

Select 20-27 credits from department list (Sem: 1-8)

**GENETICS AND DEVELOPMENTAL BIOLOGY OPTION: (50-54 credits)**

**PRESCRIBED COURSES (19 credits)**

CHEM 210(3), CHEM 212(3), CHEM 213(2) (Sem: 3-4)  
BIOL 322(3), BIOL 430(3) (Sem: 5-6)  
B M B 401(2), B M B 402(3) (Sem: 5-8)

**ADDITIONAL COURSES (17-21 credits)**

Select 2-5 credits from MATH 220 GQ(2-3), MATH 231(2), MICRB 201(3), MICRB 202(2) (Sem: 3-6)  
Select 3-4 credits from STAT 200 GQ(4), STAT 240 GQ(3), STAT 250 GQ(3), or STAT 319(3) (Sem: 5-6)

Select a minimum of 12 credits of 400-level courses, with at least 6 credits from Group I, 3 credits from Group II, and 3 credits from Group III (Sem: 5-8)

Group I -- B M B 400(2-3), B M B 450(2), BIOL 404(3), BIOL 405(3), BIOL 407(3), BIOL 410(3), BIOL 411(3), BIOL 413(3), BIOL 416(3), BIOL 422(3), BIOL 426(3), BIOL 427(3), BIOL 428(3), BIOL 432(3), BIOL 437(4), BIOL 439(3), BIOL 443(3), BIOL 448(3), BIOL 460(3), BIOL 469(3), HORT 407(3), MICRB 410(3)

Group II -- BIOL 405(3), BIOL 411(3), BIOL 414(3), BIOL 417(4), BIOL 420(3), BIOL 421(4), BIOL 425(4), BIOL 427(3), BIOL 428(3), BIOL 438(3), BIOL 443(3), BIOL 460(3), BIOL 474(3)

Group III -- BIOL 400(1-3), BIOL 407(3), BIOL 437(4), BIOL 439(3), BIOL 448(3), BIOL 461(3), BIOL 471(3), BIOL 473(2), BIOL 496(1-3), BIOL 499A IL(3), B M B 442(3), PPEM 425(4), SC 295(1-3), SC 395(1-3), SC 495(1-3)

**SUPPORTING COURSES AND RELATED AREAS (10-18 credits)**

Select 10-18 credits from department list (Sem: 1-8)

**NEUROSCIENCE OPTION: (50-54 credits)**

**PRESCRIBED COURSES (19 credits)**

B M B 401(2), B M B 402(3) (Sem: 5-8)  
BIOL 469(3), BIOL 470(3) (Sem: 5-8)  
CHEM 210(3), CHEM 212(3), CHEM 213(2) (Sem: 3-4)

**ADDITIONAL COURSES (15-16 credits)**

Select 3-4 credits from STAT 200 GQ(4), STAT 240 GQ(3), or STAT 250 GQ(3) (Sem: 3-4)

Select a minimum of 12 credits of 400-level biology courses, with at least 6 credits from Group I, 3 credits from Group II, and 3 credits from Group III (Sem: 5-8)

Group I -- B M B 400(2-3), BIOL 404(3), BIOL 409(3), BIOL 411(3), BIOL 413(3), BIOL 421(4), BIOL 426(3), BIOL 430(3), BIOL 437(4), BIOL 443(3), BIOL 460(3), BIOL 471(3), BIOL 472(3), BIOL 473(2), BIOL 479(3) (may select up to 6 credits from department list)

Group II -- BIOL 405(3), BIOL 411(3), BIOL 414(3), BIOL 417(4), BIOL 420(3), BIOL 421(4), BIOL 425(4), BIOL 427(3), BIOL 428(3), BIOL 438(3), BIOL 443(3), BIOL 460(3), BIOL 474(3)

Group III -- BIOL 400(1-3), BIOL 414(3), BIOL 417(4), BIOL 419(3), BIOL 421(4), BIOL 437(4), BIOL 439(3), BIOL 444(3), BIOL 448(3), BIOL 450W(3-5), BIOL 461(3), BIOL 471(3), BIOL 473(2), BIOL 496(1-3), BIOL 499A IL(3), SC 295(1-3), SC 395(1-3), SC 495(1-3)

**SUPPORTING COURSES AND RELATED AREAS (15-20 credits)**

Select 15-20 credits from department list (Sem: 1-8)

**PLANT BIOLOGY OPTION: (50-54 credits)**

**PRESCRIBED COURSES (22 credits)**

CHEM 210(3), CHEM 212(3), CHEM 213(2) (Sem: 3-4)  
B M B 401(2), B M B 402(3), BIOL 407(3), BIOL 414(3), BIOL 441(3) (Sem: 5-8)

**ADDITIONAL COURSES (12-13 credits)**

Select 3-4 credits from STAT 200 GQ(4), STAT 240 GQ(3), STAT 250 GQ(3), or an advanced statistics course (Sem: 3-4)

Select a minimum of 9 credits of 400-level biology courses, with at least 6 credits from Group I and 3 credits from Group II (Sem: 5-8)

Group I -- BIOL 410(3), BIOL 413(3), BIOL 427(3), BIOL 430(3), BIOL 443(3), BIOL 444(3), BIOL 446(3), BIOL 448(3), BIOL 499A IL(3), BIOTC 459(3), HORT 407(3), HORT 440W(3), PPEM 416(2-4), PPEM 425(4)

Group II -- BIOL 400(1-3), BIOL 414(3), BIOL 419(3), BIOL 439(3), BIOL 444(3), BIOL 448(3), BIOL 450W(3-5), BIOL 461(3), BIOL 496(1-3), BIOL 499A IL(3), SC 295(1-3), SC 395(1-3), SC 495(1-3)

**SUPPORTING COURSES AND RELATED AREAS (15-20 credits)**

Select 15-20 credits from department list (Sem: 1-8)

**VERTEBRATE PHYSIOLOGY OPTION: (50-54 credits)**

**PRESCRIBED COURSES (18 credits)**



CHEM 210(3), CHEM 212(3), CHEM 213(2) (Sem: 3-4)  
B M B 401(2), B M B 402(3), BIOL 472(3), BIOL 473(2) (Sem: 5-8)

#### **ADDITIONAL COURSES** (15-16 credits)

Select 3-4 credits from STAT 200 GQ(4), STAT 240 GQ(3), or STAT 250 GQ(3) (Sem: 5-8)

Select a minimum of 12 credits of 400-level courses, with at least 6 credits from Group I, 3 credits from Group II, and 3 credits from Group III (Sem: 5-8)

Group I -- BIOL 404(3), BIOL 406(3), BIOL 409(3), BIOL 411(3), BIOL 412(3), BIOL 413(3), BIOL 416(3), BIOL 421(4), BIOL 426(3), BIOL 430(3), BIOL 432(3), BIOL 437(4), BIOL 443(3), BIOL 446(3), BIOL 460(3), BIOL 469(3), BIOL 470(3), BIOL 471(3), BIOL 479(3) (may select up to 6 credits from department list)

Group II -- BIOL 405(3), BIOL 411(3), BIOL 414(3), BIOL 417(4), BIOL 420(3), BIOL 421(4), BIOL 425(4), BIOL 427(3), BIOL 428(3), BIOL 438(3), BIOL 443(3), BIOL 460(3), BIOL 474(3)

Group III -- BIOL 400(1-3), BIOL 414(3), BIOL 417(4), BIOL 419(3), BIOL 421(4), BIOL 437(4), BIOL 439(3), BIOL 444(3), BIOL 448(3), BIOL 450W(3-5), BIOL 461(3), BIOL 471(3), BIOL 473(2), BIOL 496(2), BIOL 499A IL(3), SC 295(1-3), SC 395(1-3), SC 495(1-3)

#### **SUPPORTING COURSES AND RELATED AREAS** (16-21 credits)

Select 16-21 credits from department list (Sem: 1-8)

## **Integrated B.S. in Biology/M.Ed. in Curriculum and Instruction**

This Integrated Undergraduate/Graduate (IUG) degree program combines the Bachelor of Science in Biology with the Master of Education in Curriculum and Instruction, Science Education emphasis. The program is designed to be completed in five years. The program enables highly qualified and motivated students to delve deeply into a scientific content area and to pursue graduate level preparation in the theory and practice of teaching. Most students in this option intend to seek Pennsylvania teacher certification, and a semester of student teaching comprises part of their final year of studies. The IUG may also be suitable for a student who does not need to become certified, because they intend to teach in a private secondary school or a non-formal educational setting; in such cases, the second graduate semester will be a program of studies determined through consultation with the graduate advisor and customized for the student's specific needs.

For specific instructions on applying to the program, please consult the "Application Process" section of the IUG description for the Biology B.S. degree in the *Undergraduate Bulletin*. Application materials to be submitted include an undergraduate transcript, statement of purpose, draft plan of study, two letters of recommendation, and concurrent submission of an application for master's study to the graduate program in Curriculum and Instruction, Science Education emphasis area. Additional details about the graduate application procedure can be found above in the section, "Admissions Requirements."

IUG students fulfill all degree requirements for a B.S. in the Eberly College of Science. If a student chooses to leave the program without completing M.Ed. requirements, he or she may still receive the relevant B.S. degree, after all B.S. requirements are completed.

For the M.Ed. degree, students must earn at least 30 credits at the 400/500 level, at least 18 of them at the 500 level. One graduate semester is usually devoted to full time student teaching. Additional graduate coursework is completed in a second semester. Courses required for the M.Ed. degree include a course in learning theory (e.g., SCIED 552(3)), a course in research methods (e.g., SCIED 558(3)), a course in curriculum (e.g., SCIED 550), and a course in research ethics (C I 590(1)).

Students pursuing teacher certification (the usual option) additionally complete a 500-level EDTHP course (3), C I 595(6), and C I 496(6). SCIED 558(3), C I 496(6), and C I 595(6) comprise the student-teaching semester course load. Students who are not pursuing teacher certification substitute 15 credits of other 400 or 500-level coursework for the student-teaching semester; those courses are selected in consultation with their advisors, in order to address the students' specific career aspirations.

124 credits are required for the B.S. degree and 30 credits for the M.Ed. degree. The following courses may be double-counted toward both the B.S. and the M.Ed. degrees, up to a limit of 12 credits: EDTHP 500-level courses (3), SCIED 411(3) & SCIED 412(3), and SCIED 500-level courses. Note that at least 50% of credits proposed for double-counting must be at the 500 level.

There are a number of other requirements for Pennsylvania teacher certification, including state-required tests and clearances, as well as coursework that can be completed at either the undergraduate or graduate level. Some courses, not enumerated above, that are usually required to satisfy teacher certification requirements include C I 280(3), SPLED 400(3), and C I 495C(3). Please note that changes in Pennsylvania certification requirements are common; students should check the Certification FAQ page at the Penn State

Science Education website for updates and clarification about the specific requirements that affect them, based on their admission date to the IUG program option. Note also that students in the IUG program option are not required to complete all Penn State teacher certification requirements in order to receive their B.S. and M.Ed. degrees, as long as they have completed the requirements for those degrees, as described in the undergraduate and graduate *Bulletins*. For example, a student who has completed all degree requirements but has not yet received a score for the Pennsylvania-required Biology PRAXIS exam may be awarded both of his or her earned degrees.

**[1]** A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

Last Revised by the Department: Fall Semester 2016

Blue Sheet Item #: 45-01-132

Review Date: 8/23/16

UCA Revision #1: 8/2/06

UCA Revision #2: 7/26/07

SC

## Biotechnology

*University Park, Eberly College of Science (BIOTC)*

Director of Curricular Affairs, Meredith Defelice, *in charge*

Biotechnology may be broadly defined as the application of principles of molecular and cell science in the production of biologically important or industrially useful products. Therefore, students in the Biotechnology major will (1) acquire a strong foundation in the life and chemical sciences, (2) learn how fundamental science is applied to problems through biotechnology, (3) develop basic laboratory skills, perform standard techniques, work with state-of-the-art instrumentation, describe and evaluate analytical methodology used in biotechnology, and (4) become familiar with societal concerns and governmental regulations regarding the biotechnology industry. One very important strength of this major is the extensive laboratory experience each student receives. In the General option, students are very strongly encouraged to consider Cooperative Education with industry as an integral part of their curriculum. In addition to the General option in Biotechnology, the major also offers the Clinical Laboratory Science option.

In order to be eligible for entrance to the Biotechnology major, a student must have: (1) attained at least a 2.00 cumulative grade-point average, and (2) completed CHEM 110 GN(3), CHEM 111 GN(1), CHEM 112 GN(3), and MATH 140 GQ(4) and earned a grade of C or better in each of these courses.

For the B.S. degree in Biotechnology, a minimum of 125 credits is required.

*Scheduling Recommendation by Semester Standing given like (Sem: 1-2)*

**GENERAL EDUCATION:** 45 credits

(15 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)  
(See description of General Education in this bulletin.)

**FIRST-YEAR SEMINAR:**

(Included in REQUIREMENTS FOR THE MAJOR)

**UNITED STATES CULTURES AND INTERNATIONAL CULTURES:**

(Included in GENERAL EDUCATION course selection)

**WRITING ACROSS THE CURRICULUM:**

(Included in REQUIREMENTS FOR THE MAJOR)

**REQUIREMENTS FOR THE MAJOR:** 95 credits **[87]**

(This includes 15 credits of General Education courses: 9 credits of GN courses; 6 credits of GQ courses.)

**COMMON REQUIREMENTS FOR MAJOR (ALL OPTIONS):** 47 credits

**PRESCRIBED COURSES** (47 credits)

CHEM 110 GN(3) **[1]**, CHEM 111 GN(1) **[1]**, CHEM 112 GN(3) **[1]**, CHEM 113 GN(1), MATH 140 GQ(4) **[1]**, MATH 141 GQ(4), MICRB 201(3) **[85]**, MICRB 202(2), PSU 016(1) (Sem: 1-2)

PHYS 250 GN(4), PHYS 251 GN(4) (Sem: 1-4)

BMB 211, BMB 221, BMB 251(3) **[85]**, BMB 252(3) **[85]**, MICRB 410(3), MICRB 421(3) (Sem: 3-4)

MICRB 421(3) (Sem: 5-6)

**REQUIREMENTS FOR THE OPTION:** 48 credits

**GENERAL BIOTECHNOLOGY OPTION:** (48 credits)

**PRESCRIBED COURSES** (20 credits)

BIOL 322(3) (Sem: 3-4)

BMB 442(3) (Sem: 5-6)

BIOTC 416(2), BIOTC 459(3), BIOTC 479(3), BIOTC 489(3), STAT 250 GQ(3) (Sem: 5-8)

**ADDITIONAL COURSES** (6-8 credits)

CHEM 202(3), CHEM 203(3); or CHEM 210(3), CHEM 212(3), CHEM 213(2) (Sem: 3-4)

**SUPPORTING COURSES AND RELATED AREAS** (20-22 credits)

Select 14-16 credits from department list C (Sem: 3-8)

Select 6 credits from any 400-level BMB/BIOTC/MICRB lecture course, FDSC 408(2) or department list D (additional 400-level courses) (Sem: 5-8)

**CLINICAL LABORATORY SCIENCE OPTION:** (48 credits)

This option provides both the academic and clinical preparation for students interested in a career as a clinical laboratory scientist. Positions are found in hospital, physician-office, reference, industrial, and research laboratories. To complete baccalaureate degree requirements, students enter a ten-month clinical practicum (MICRB 405A-F) at an affiliate hospital for the senior year. (Current affiliations are with Mount Nittany Medical Center, State College and Pennsylvania Hospital, Philadelphia.) Students are recommended for a fixed number of hospital positions on a competitive basis. Cumulative grade-point average and hospital school admission requirements serve as criteria for recommendation. The B.S. degree is awarded at the first commencement following completion of the clinical practicum.

**PRESCRIBED COURSES** (36 credits)

BMB 212(1), MICRB 412(3), MICRB 422(2) (Sem: 5-6)

MICRB 405A(8), MICRB 405B(1), MICRB 405C(6), MICRB 405D(5), MICRB 405E(7), MICRB 405F(3) (Sem: 7-8)

**ADDITIONAL COURSES** (9-11 credits)

BIOL 322(3) or BIOL 222(3) (Sem: 3-4)

CHEM 202(3), CHEM 203(3); or CHEM 210(3), CHEM 212(3), CHEM 213(2) (Sem: 3-4)

**SUPPORTING COURSES AND RELATED AREAS** (1-3 credits)

Select 1-3 credits from department list (Sem: 3-8)

## **Integrated B.S. in Biotechnology - Master of Biotechnology in Biotechnology**

PROFESSOR Loida Escote-Carlson, in charge

The integrated B.S. in Biotechnology-Master of Biotechnology degree program is designed to enable qualified undergraduate students in the B.S. Biotechnology program to graduate in five years with the Master of Biotechnology degree. The requirements of the Master of Biotechnology degree are designed to prepare students for diverse career opportunities in the burgeoning biotechnology industry. The integrated B.S. Biotechnology-Master of Biotechnology program will enhance the preparation and qualifications of B.S. Biotechnology students seeking entry-level positions in biotechnology and related industries. At the same time, students develop a practical knowledge of the laboratory techniques that underlie current research in the life sciences that will serve as excellent preparation for those students in the Master of Biotechnology program who later decide to pursue further graduate degrees.

A maximum of 12 credits will be cross-counted towards the B.S. and Masters degrees, from the following courses:

BMB 400(2-3), BIOTC 479(3), IBIOS 571(2), IBIOS 591(1), and IBIOS 593(3).

**B.S. Biotechnology Requirements:**

Total credits required: 125

GENERAL EDUCATION: 46 credits (15 of these are included in the REQUIREMENTS FOR THE MAJOR)

REQUIREMENTS FOR THE MAJOR: 94-95 credits

Prescribed courses: 67 credits

Additional courses: 6-9 credits

Supporting courses and related areas: 18-21 credits

**Master of Biotechnology Requirements:**

Total credits required: 30 (18 of which must be from 500-level courses)

Required courses: 16-19 credits  
Electives: 11-14 credits

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.  
[85] To graduate with a B.S. degree in Biotechnology, a grade of C or better is required in two of the following courses: MICRB 201, B M B/MICRB 251, B M B/MICRB 252.

[87] To graduate with a B.S. degree in Biotechnology, a grade of C or better is required in 9 credits of any BIOTC, B M B, or MICRB 400-level course except B M B 442, B M B 443W, B M B 445W, B M B 448, B M B 488, B M B 496, MICRB 421W, MICRB 422, MICRB 447.

Last Revised by the Department: Fall Semester 2016

Blue Sheet Item #: 45-01-133

Review Date: 08/23/16

UCA Revision #1: 8/3/06

SC

"It is an elective course covering Scientific Visualization and they plan on offering it again and tie it with data science (data visualization) which is an emerging area in Computing. By keeping this course they would not need to develop and approve a new course proposal."

## Chemistry

*University Park, Eberly College of Science (CHEM)*

PROFESSOR Mark Maroncelli, *Assistant Head for Undergraduate Education*

This major provides a strong foundation in the theory and practice of chemistry. Mathematics and physics are emphasized, since these subjects are essential to the understanding of chemistry. Courses in English and electives ensure study in non-technical subjects which broaden the student's general education and enables him or her to relate the major to other fields of knowledge.

In order to be eligible for entrance to the Chemistry major, a student must have: 1) Attained at least a 2.00 cumulative grade-point average. 2) Completed CHEM 110 GN(3), CHEM 111 GN(1), CHEM 112 GN(3), CHEM 113 GN(1), CHEM 210(3), MATH 140 GQ(4), and MATH 141 GQ(4); earned a grade of C or better in each of these courses; and earned a combined grade point average of at least 2.50 in these courses. (Note: If courses are repeated, only the higher grade will be used in this calculation.)

For the B.S. degree in Chemistry, a minimum of 125 credits is required with a cumulative grade point average of at least a 2.00 in these courses. A grade of C or better is required in all courses within the major field.

*Scheduling Recommendation by Semester Standing given like (Sem: 1-2)*

**GENERAL EDUCATION:** 45 credits

(15 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)  
(See description of General Education in this bulletin.)

**FIRST-YEAR SEMINAR:** 1-3 credits

**UNITED STATES CULTURES AND INTERNATIONAL CULTURES:**

(Included in GENERAL EDUCATION course selection)

**WRITING ACROSS THE CURRICULUM:**

(Included in REQUIREMENTS FOR THE MAJOR)

**REQUIREMENTS FOR THE MAJOR:** 94 credits

(This requirement includes 15 credits of General Education courses: 9 credits of GN courses; 6 credits of GQ courses.)

**PRESCRIBED COURSES** (54 credits)

CHEM 110 GN(3)[1], CHEM 111 GN(1)[1], CHEM 112 GN(3)[1], CHEM 113 GN(1)[1], MATH 140 GQ(4)[1],  
MATH 141 GQ(4)[1] (Sem: 1-2)

PHYS 211 GN(4), PHYS 212 GN(4), PHYS 213 GN(2), PHYS 214 GN(2) (Sem: 1-4)

MATH 231(2) (Sem: 3-4)

CHEM 210(3)[1], CHEM 212(3)[1], CHEM 213(2)[1], CHEM 227(4)[1], CHEM 310(3)[1], CHEM 316(1), CHEM 450(3)[1], CHEM 452(3)[1], CHEM 457(2)[1] (Sem: 5-6)

#### **ADDITIONAL COURSES** (23 credits)

Select 3 credits from MATH 250(3) or STAT 401(3) (Sem: 5-8)

Select 4 credits from advanced laboratory courses[1]: CHEM 423W(4), CHEM 425W (4), CHEM 431W(4), CHEM 459W(4) (Sem: 5-8)

Select 16 credits of chemistry at the 400 level[1]. Up to 6 co-op credits (2 each of SC 295, SC 395, SC 495) may be used in this category. Chemical Research, CHEM 494(1-10) may be used, but the total of CHEM 494 credits plus co-op credits may not exceed 8. (Sem: 5-8)

#### **SUPPORTING COURSES AND RELATED AREAS** (17 credits)

These 17 credits may include any courses not on the Chemistry Department list of excluded courses except that CHEM 494 may not be used, and only one credit of each SC 295, SC 395, and SC 495 is allowed in this category. (Sem: 1-8)

## **Integrated B.S. in Chemistry/M.Ed. in Curriculum and Instruction**

These Integrated Undergraduate/Graduate (IUG) degree programs combine the Bachelor of Science in Chemistry with the Master of Education in Curriculum and Instruction, Science Education emphasis. The programs are designed to be completed in five years. The programs enable highly qualified and motivated students to delve deeply into a scientific content area and to pursue graduate level preparation in the theory and practice of teaching.

For detailed instructions on applying to the program, please consult the "Application Process" section of the IUG description for the Chemistry B.S. degree in the *Undergraduate Bulletin*. Application materials to be submitted include an undergraduate transcript, statement of purpose, draft plan of study, two letters of recommendation, and concurrent submission of an application for master's study to the graduate program in Curriculum and Instruction, Science Education emphasis area. Additional details about the graduate application procedure can be found above in the section, "Admissions Requirements."

IUG students fulfill all degree requirements for a B.S. in the Eberly College of Science. If a student chooses to leave the program without completing M.Ed. requirements, he or she may still receive the relevant B.S. degree, after all B.S. requirements are completed.

For the M.Ed. degree, students must earn at least 30 credits at the 400/500 level, at least 18 of them at the 500 level. One graduate semester is devoted to full time student teaching. Additional graduate coursework is completed in a second graduate semester. Courses required for the M.Ed. degree include SCIED 552(3), SCIED 558(3), a 500-level EDTHP course (3), C I 590(1), C I 595(12), and a 500-level course in curriculum (e.g., C I 550(3)). Of these, SCIED 558(3) and C I 595(12) comprise the student teaching semester course load.

124 credits are required for the B.S. degree and 30 credits for the M.Ed. degree. The following courses may be double-counted toward both the B.S. and the M.Ed. degrees, up to a limit of 12 credits: EDTHP 500-level courses (3), SCIED 411(3) & SCIED 412(3), and SCIED 500-level courses. Note that at least 50% of credits proposed for double-counting must be at the 500 level.

There are a number of other requirements for Pennsylvania teacher certification, including state-required tests and clearances, as well as coursework that can be completed at either the undergraduate or graduate level. Some courses, not enumerated above, that are usually required to satisfy teacher certification requirements include C I 280(3), SPLED 400(3), and C I 495C(3). Please note that changes in Pennsylvania certification requirements are common; students should check the Certification FAQ page at the Penn State Science Education website for updates and clarification about the specific requirements that affect them, based on their admission date to the IUG program option. Note also that students in the IUG program option are not required to complete all Penn State teacher certification requirements in order to receive their B.S. and M.Ed. degrees, as long as they have completed the requirements for those degrees, as described in the undergraduate and graduate *Bulletins*. For example, a student who has completed all degree requirements but has not yet received a score for the Pennsylvania-required Biology PRAXIS exam may be awarded both of his or her earned degrees.

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

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## Data Sciences

University Park, College of Engineering (DATSC)

University Park, College of Information Sciences and Technology (DATSC)

University Park, Eberly College of Science (DATSC)

Mary Beth Rosson, Associate Dean, Information Sciences and Technology; Chita Das, Department Head, Computer Science and Engineering, College of Engineering

Not all options are available at all Colleges. Contact the College you are interested in entering to determine which options are offered.

The inter-college Data Sciences major will educate students on the technical fundamentals of data sciences, with a focus on developing the knowledge and skills needed to manage and analyze large scale unstructured data to address an expanding range of problems in industry, government, and academia. The underlying knowledge for data sciences derives from machine learning, data mining, computer science, statistics, and visualization, and the emerging science of managing and analyzing data at scale. Students will gain breadth of knowledge through common core classes, as well as depth in one of three options. After taking common courses during the pre-major stage, students will choose among options focused on application (College of IST), computation (College of Engineering) and science (College of Science). Students in all three options will come together in their junior and senior years for two shared capstone experiences. In combination the three options position Penn State to offer highly trained professionals who understand data science's multiple dimensions for a growing segment of the U.S. economy.

**Applied Data Sciences** - This option focuses on the principles, methods, and tools for assembly, validation, organization, analysis, visualization, and interpretation of large and heterogeneous data, to support data-driven discovery and decision making, with emphasis on addressing pressing scientific, organizational, and societal challenges. A combination of required and elective courses provides students with the training and skills needed to develop advanced tools and domain-specific analyses that yield actionable knowledge from data. This option also provides critical analytical skills needed to assess the benefits and limitations of data analytics across a broad range of applications.

**Computational Data Sciences** - This option focuses on the computational foundations of the data sciences, including the design, implementation and analysis of software that manages the volume, heterogeneity and dynamic characteristics of large data sets and that leverages the computational power of multicore hardware. Students in this option will take upper-level courses in computer science and related fields to develop the skills necessary to construct efficient solutions to computational problems involving Big Data.

**Statistical Modeling Data Sciences** - This option focuses on statistical models and methods that are needed to discover and validate patterns in Big Data. Students in this option will take upper-level statistics and mathematics courses, learning to apply the theoretical machinery of quantitative models to the solution of real-world problems involving Big Data.

### Entrance Requirements

To be eligible for entrance into the Data Sciences major, a degree candidate must be enrolled in the College of Information Sciences and Technology, the College of Engineering, the Eberly College of Science, or the Division of Undergraduate Studies and satisfy requirements for entrance to the major.

Specific entrance requirements include:

1. The degree candidate must be taking, or have taken, a program appropriate for entry to the major as shown in the bulletin.
2. The degree candidate must complete the following entrance-to-major requirements: MATH 140 GQ (4) [1]; MATH 141 GQ (1) [1]; CMPSC 121 (3) [1]; CMPSC 122 (3); STAT 200 (GQ) (4)[1]; IST 210 (3)[1]. These courses must be completed by the end of the semester during which the entrance to major process is carried out.

For the B.S. degree in Data Sciences, a minimum of 125 credits is required (at least 18 credits must be taken at the 400 level).

**GENERAL EDUCATION:** 45 credits

(15 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)

(See description of General Education in this bulletin.)

**FIRST-YEAR SEMINAR:**

(Included in ELECTIVES or GENERAL EDUCATION course selection)

**UNITED STATES CULTURES AND INTERNATIONAL CULTURES:**

(Included in GENERAL EDUCATION course selection, or REQUIREMENTS FOR THE MAJOR)

**WRITING ACROSS THE CURRICULUM:**

(Included in REQUIREMENTS FOR THE MAJOR)

**ELECTIVES:** 5-18 credits

**REQUIREMENTS FOR THE MAJOR:** 77-90 credits

(This includes 15 credits of General Education courses: 9 credits of GWS and 6 credits of GQ courses.)

**COMMON REQUIREMENTS FOR THE MAJOR (ALL OPTIONS):** 50 credits

**PRESCRIBED COURSES** (41 credits)

CMPSC 121 GQ(3)[1], CMPSC 122(3)[1], DS 220(3)[1], DS 300(3)[1], DS 340(3)[1], DS 440(3)[1], ENGL 202C GWS(3), IST 210(3)[1], MATH 140 GQ(4)[1], MATH 141 GQ(4)[1], MATH 220 GQ(2)[1], STAT 200 GQ(4)[1], STAT 380(3)[1]

**ADDITIONAL COURSES** (9 credits)

CAS 100 GWS(3), ENGL 015 GWS(3); ENGL 137/CAS 137 GWS(3), ENGL 138/CAS 138 GWS(3) (Sem: 1-6)  
STAT 318/MATH 318(3)[1]; STAT 414/MATH 414(3)[1] (Sem: 3-4)

**REQUIREMENTS FOR THE OPTION:** 27-40

**APPLIED DATA SCIENCES:** 40 credits

**PRESCRIBED COURSES** (22 credits)

IST 110 GS(3)[1], IST 230(3)[1], DS 200(3)[1], DS 310(3)[1], DS 320(3)[1], DS 330(3)[1], DS 410(3)[1], IST 495(1)[1] (Sem: 5-6)

**ADDITIONAL COURSES** (6 credits)

SRA 231(3); IST 442 IL(3); SODA 308(3); IST 445(3) (Sem: 5-8)  
IST 337(3); IST 441(3); DS 402(3); IST 462(3) (Sem: 5-8)

**SUPPORTING COURSES AND RELATED AREAS** (12 credits)

Select 6 credits from Applied Option List A (Sem: 5-8)

Select 6 credits from Applied Option List B (Sem: 5-8)

(Students may apply up to 3 credits of ROTC as option list credits and 3 credits of ROTC as GHA credits)

**COMPUTATIONAL DATA SCIENCES:** 38 credits

**PRESCRIBED COURSES** (25 credits)

MATH 230(4)[1], CMPSC 360(3)[1], CMPSC 448(3), CMPSC 465(3)[1], STAT 415/MATH 415(3)[1], CMPSC 461(3), DS 410(3)[1], CMPSC 442(3)

**ADDITIONAL COURSES** (1 credit)

1 credit of First-Year Seminar (Sem: 1-2)

**SUPPORTING COURSES AND RELATED AREAS** (12 credits)

Select 6 credits from Option List A courses

Select 6 credits from Option List B courses

(Students may apply up to 3 credits of ROTC as option list credits and 3 credits of ROTC as GHA credits)

**STATISTICAL MODELING DATA SCIENCES:** 27 credits

**PRESCRIBED COURSES** (11 credits)

MATH 230(4), STAT 184(1), STAT 440(3), STAT 462(3)

**ADDITIONAL COURSES** (4 credits)

MATH 311W(3)[1]; CMPSC 360(3)[1] (Sem: 5-8)

1 credit of First-Year Seminar (Sem: 1-2)

**SUPPORTING COURSES AND RELATED AREAS** (12 credits)

Select 6 credits from Quantitative Modeling Option List A courses

Select 6 credits from Quantitative Modeling Option List B courses

(Students may apply up to 3 credits of ROTC as option list credits and 3 credits of ROTC as GHA credits)

**List of Applied Data Sciences Option Courses**

**List of Computational Data Sciences Courses**

**List of Statistical Modeling Data Sciences Courses**

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

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Blue Sheet Item #: 44-02-038

Review Date: 10/13/2015

## Forensic Science

*University Park, The Eberly College of Science (FRNSC)*

Forensic Science is the application of scientific principles and methods to assist criminal and civil investigations and litigation. This major is an inter-college collaboration among academic units and provides students with a strong foundation in the biological, physical, and mathematical sciences. It introduces them to relevant topics in criminalistics forensic chemistry, forensic biology, crime scene investigation, and appropriate social sciences. Students are educated on the role of forensic scientists in the criminal justice system, the collection and analysis of scientific evidence, and the manner in which evidence is presented in court. Graduates of this major could pursue employment as a scientist in a federal, state, or private forensic laboratory or with insurance companies, homeland security agencies, or the judicial community. Graduates could also choose to pursue advanced degrees, for example, in forensic science, medicine, psychology, anthropology, pathology, odontology, entomology, toxicology, law, or in the general sciences.

In order to be eligible for entrance to the Forensic Science major, a student must have: (1) attained at least a 2.00 cumulative grade point average (2) completed CHEM 110 GN(3), CHEM 111 GN(1), CHEM 112 GN(3), FRNSC 210(3), MATH 140 GQ(4), and earned a grade of C or better in each of these courses.

For the B.S in Forensic Science a minimum of 124-126 credits is required.

*Scheduling Recommendation by Semester Standing given like (Sem: 1-2)*

**GENERAL EDUCATION:** 45 credits

(18 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)  
(See description of General Education in this bulletin)

**FIRST YEAR SEMINAR:**

(Included in GENERAL EDUCATION course selection or REQUIREMENTS FOR THE MAJOR)

**UNITED STATES CULTURES AND INTERNATIONAL CULTURES:**

(Included in GENERAL EDUCATION course selection or REQUIREMENTS FOR THE MAJOR)

**WRITING ACROSS THE CURRICULUM:**

(Included in REQUIREMENTS FOR THE MAJOR)

**REQUIREMENTS FOR THE MAJOR:** 97-99 credits

(This includes 18 credits of General Education courses: 9 credits of GN courses; 6 credits of GQ courses; 3 credits of GH courses.)

**COMMON REQUIREMENTS FOR THE MAJOR (ALL OPTIONS):** 63 credits

**PRESCRIBED COURSES:** (52 credits)[1]

CHEM 110 GN(3), CHEM 111 GN(1), CHEM 112 GN(3), CHEM 113 GN(1), CHEM 210(3), CHEM 212(3), CHEM 213(2), MATH 140 GQ(4), MATH 141 GQ(4) (Sem: 1-4)

PHIL 132 GH(3) (Sem: 1-8)

FRNSC 100(3) (Sem: 2)

FRNSC 210(3) (Sem: 3)

FRNSC 410(2) (Sem: 4-6)

FRNSC 415(2) (Sem: 5-6)

FRNSC 411(3), FRNSC 413(3) (Sem: 5-7)

STAT 250 GQ(3) (Sem: 5-8)

FRNSC 400(1), FRNSC 475(1), FRNSC 485(4) (Sem: 7-8)

**ADDITIONAL COURSES:** (11 credits)[1]

CRIM 100 GS(3) or CRIM 113 US(3) (Sem: 1-6)

PHYS 250 GN(4), PHYS 251 GN(4); or PHYS 211 GN(4), PHYS 212 GN(4) (Sem: 2-6)

**REQUIREMENTS FOR THE OPTION:** 34-36 credits

**FORENSIC BIOLOGY OPTION:** (36 credits)



**PRESCRIBED COURSES:** (21 credits)**[1]**

BMB 251(3), MICRB 201(3), MICRB 202(2) (Sem: 1-4)  
BMB 400(3), BMB 401(3), BMB 442(3) (Sem: 5-7)  
FRNSC 421(4) (Sem: 7-8)

**ADDITIONAL COURSES:** (9 credits)**[1]**

BIOL 222(3) or BIOL 322(3) (Sem: 3-5)  
Select 6 credits from BMB 402(3), BMB 428(3), BMB 433(3), BIOL 405(3), BIOL 422(3), BIOL 460(3) (Sem: 6-8)

**SUPPORTING COURSES AND RELATED AREAS** (6 credits)

Select 6 credits in consultation with adviser (Sem: 3-8)

**FORENSIC CHEMISTRY OPTION:** (34 credits)**PRESCRIBED COURSES:** (19 credits)**[1]**

BIOL 110 GN(4), BIOL 230W GN(4) (Sem: 1-4)  
CHEM 227(4) (Sem: 3-5)  
CHEM 425(3) (Sem: 5-7)  
FRNSC 427(4) (Sem: 6-8)

**ADDITIONAL COURSES:** (9 credits)**[1]**

Select 9 credits from BMB 428(3), CHEM 410(3), CHEM 412(3), CHEM 423(4), CHEM 430(3), CHEM 431(4), CHEM 450(3), CHEM 452(3) (Sem: 5-8)

**SUPPORTING COURSES AND RELATED AREAS** (6 credits)

Select 6 credits in consultation with adviser (Sem: 3-8)

**[1]** A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

Last Revised by the Department: Fall Semester 2014

Blue Sheet Item #: 43-02-066

Review Date: 10/7/2014

UCA Revision #1: 8/4/06

UCA Revision #2: 7/27/07

SC

## Mathematics

*Altoona College (MTAAL)*

*University Park, Eberly College of Science (MTHBA)*

PROFESSOR YUXI ZHENG, *Chair, Department of Mathematics*

Two degrees are offered in mathematics: the Bachelor of Arts and the Bachelor of Science. Both programs have a common core of mathematics courses; both programs prepare students for graduate work in mathematics. In addition, the Bachelor of Arts degree is oriented toward applications of mathematics in the arts and the humanities. The Bachelor of Science degree has a number of options. These options are oriented toward actuarial science, applied and industrial mathematics, computational mathematics, graduate study and systems analysis.

Many of the options are designed for students who want to use mathematics in industry, commerce, or government. In short, the degree requirements have the flexibility to fit many individual interests. The student, with the assistance of a faculty adviser, should select an option by the end of the sophomore year.

In order to be eligible for entrance to the Mathematics major, a student must have: 1) attained at least a 2.00 cumulative grade point average; and 2) completed MATH 140 GQ(4) and MATH 141 GQ(4) and earned a grade of C or better in each of these courses.

For the B.A. degree in Mathematics, a minimum of 120 credits is required.

*Scheduling Recommendation by Semester Standing given like (Sem: 1-2)*

**GENERAL EDUCATION:** 45 credits

(6 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)

(See description of General Education in this bulletin.)

**FIRST-YEAR SEMINAR:**

(Included in ELECTIVES or GENERAL EDUCATION course selections)

**UNITED STATES CULTURES AND INTERNATIONAL CULTURES:**

(Included in GENERAL EDUCATION or BACHELOR OF ARTS DEGREE REQUIREMENTS course selections)

**WRITING ACROSS THE CURRICULUM:**

(Included in REQUIREMENTS FOR THE MAJOR)

**ELECTIVES:** 0-1 credit

**BACHELOR OF ARTS DEGREE REQUIREMENTS:** 24 credits

(3 of these 24 credits are included in the REQUIREMENTS FOR THE MAJOR, GENERAL EDUCATION, or ELECTIVES and 0-12 credits are included in ELECTIVES if foreign language proficiency is demonstrated by examination.)

(See description of Bachelor of Arts Degree Requirements in this bulletin.)

**REQUIREMENTS FOR THE MAJOR:** 56 credits

(This includes 6 credits of General Education GQ courses.)

**PRESCRIBED COURSES** (27-29 credits)

MATH 140 GQ(4)[1], MATH 141 GQ(4)[1], MATH 220 GQ(2-3)[1], MATH 230(4)[1], MATH 311W(3-4)[1],

MATH 312(3)[1], STAT 200 GQ(4) (Sem: 1-4)

MATH 403(3)[1] (Sem: 5-8)

**ADDITIONAL COURSES** (18-19 credits)

CMPSC 101 GQ(3) or CMPSC 121 GQ(3) or CMPSC 201 GQ(3) (Sem: 1-2)

MATH 250(3)[1] or MATH 251(4)[1] (Sem: 3-4)

MATH 435(3)[1] or MATH 436(3)[1] (Sem: 5-8)

Select 3 credits[1] from MATH 411(3), MATH 412(3), MATH 417(3), MATH 419(3), or MATH 421(3) (Sem: 5-8)

Select 6 credits[1] of 400-level MATH courses except MATH 401(3), MATH 405(3), MATH 406(3), MATH 441(3), MATH 470(3), MATH 471(4) (Sem: 5-8)

**SUPPORTING COURSES AND RELATED AREAS** (8-11 credits)

Select 8-11 credits from department list (Sem: 3-8)

**Integrated B.A. in Mathematics and Master of Applied Statistics (M.A.S.)**

The Integrated Undergraduate-Graduate (IUG) degree with B.A. in Mathematics and Master of Applied Statistics (M.A.S.) is designed to be completed in five years. This integrated degree will enable a select number of highly qualified and career oriented students to obtain training in statistics focused on developing data analysis skills, and exploration of core areas of applied statistics at the graduate levels in addition to an undergraduate degree in Mathematics. The M.A.S. degree is a professional masters degree that emphasizes applications. The degree prepares students with interests in mathematics, computation, and the quantitative aspects of science for careers in industry and government as statistical analysts. Research divisions in the pharmaceutical industry, quality control, and quality engineering divisions in manufacturing companies, clinical research units, corporate planning and research units, and other data intensive positions require persons with training in mathematics, computation, database management, and statistical analysis, which this program will provide.

**Application Process**

The number of openings in the integrated B.A. in Mathematics and M.A.S. program is limited. Admission will be based on specific criteria and the recommendation of faculty. Applicants to the integrated program:

Must be enrolled in the Mathematics B.A. program.

Must have completed at least 60 credits of the undergraduate degree program including the two courses: STAT 414 and STAT 415 and the students must apply to the integrated program prior to completing 110 credits.

Must submit a transcript and a statement of purpose.

Must present a departmental approved plan of study in the application process in consultation with the M.A.S. program director.

Must be recommended by the chair of Mathematics Department's undergraduate program committee.

Two additional recommendation letters must be sent to the M.A.S. admissions committee.

Must submit the GRE to the M.A.S. admissions committee.

Must apply to the M.A.S. program in Statistics.

For the IUG B.A. in Mathematics and M.A.S. degree, 120 credits are required for the B.A. and 30 credits for the M.A.S. The following twelve graduate level credits (number of credits in parentheses) can apply to both B.A. and M.A.S. degrees, six of these are at the 500 level: STAT 414(3), STAT 415(3), STAT 501(3), STAT 502(3).

Assuming all requirements for the B.A. in Mathematics are completed, students in the program can complete the B.A. degree and not advance to the M.A.S. degree if they desire.

### **Degree Requirements**

IUG Math B.A. students must fulfill the Math B.A. requirement while counting these prescribed Statistics courses (15 credits)  
STAT 220(3)\*, STAT 414(3), STAT 415(3), STAT 501(3), STAT 502(3)

### **IUG M.A.S. Requirements** (30 credits)

STAT 414(3), STAT 415(3), STAT 501(3), STAT 502(3), STAT 580(2) and STAT 581(1)\*\*

### **Electives:** (15 credits)

Select from STAT 464(3), STAT 503(3), STAT 504(3), STAT 505(3), STAT 506(3), STAT 507(3), STAT 508(3), STAT 509(3), STAT 510(3) and the departmental list of additional courses for the M.A.S. program with the approval of the adviser.

For the IUG B.A. in Mathematics and M.A.S. degree, the four courses: STAT 414(3), STAT 415(3), STAT 501(3) and STAT 502(3) can apply to both the B.A. and M.A.S. degrees.

\*Can be waived for students with an equivalent course, e.g. STAT 250 GQ(3) or STAT 301 GQ(3).

\*\* For all students in the M.A.S. program, the STAT 581(1) course will have a comprehensive written project report required as part of the course, which serves as the culminating experience.

**[1]** A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

Last Revised by the Department: Fall Semester 2011

Blue Sheet Item #: 40-04-097

Review Date: 01/10/2012

UCA Revision #1: 8/18/06

UCA Revision #2: 7/30/07

SC

## **Mathematics**

*Altoona College (MTSAL)*

*University Park, Eberly College of Science (MTHBS)*

Not all options are available at every campus. Contact the campus you are interested in attending to determine which options are offered.

PROFESSOR YUXI ZHENG, *Chair, Department of Mathematics*

Two degrees are offered in mathematics: the Bachelor of Arts and the Bachelor of Science. Both programs have a common core of mathematics courses; both programs prepare students for graduate work in mathematics. In addition, the Bachelor of Arts degree is oriented toward applications of mathematics in the arts and the humanities. The Bachelor of Science degree has a number of options. These options are oriented toward actuarial science, applied and industrial, computational mathematics, graduate study and systems analysis.

Many of the options are designed for students who want to use mathematics in industry, commerce, or government. In short, the degree requirements have the flexibility to fit many individual interests. The

student, with the assistance of a faculty adviser, should select an option by the end of the sophomore year.

In order to be eligible for entrance to the Mathematics major, a student must have: 1) attained at least a 2.00 cumulative grade point average; and 2) completed MATH 140 GQ(4) and MATH 141 GQ(4) and earned a grade of C or better in each of these courses.

For the B.S. degree in Mathematics, a minimum of 120 credits is required.

*Scheduling Recommendation by Semester Standing given like (Sem: 1-2)*

**GENERAL EDUCATION:** 45 credits

(6 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)

(See description of General Education in this bulletin.)

**FIRST-YEAR SEMINAR:**

(Included in ELECTIVES or GENERAL EDUCATION course selections)

**UNITED STATES CULTURES AND INTERNATIONAL CULTURES:**

(Included in GENERAL EDUCATION course selection)

**WRITING ACROSS THE CURRICULUM:**

(Included in REQUIREMENTS FOR THE MAJOR)

**ELECTIVES:** 0-1 credit

**REQUIREMENTS FOR THE MAJOR:** 80-83 credits

(This includes 6 General Education GQ courses)

**COMMON REQUIREMENTS FOR THE MAJOR (ALL OPTIONS):** 30-32 credits

**PRESCRIBED COURSES** (24-25 credits)

MATH 140 GQ(4)[1], MATH 141 GQ(4)[1], STAT 200 GQ(4) (Sem: 1-4)

MATH 220 GQ(2)[1], MATH 230(4)[1], MATH 311W(3-4)[1], MATH 312(3)[1] (Sem: 3-4)

**ADDITIONAL COURSES** (6-7 credits)

CMPSC 101 GQ(3) or CMPSC 121 GQ(3) or CMPSC 201 GQ(3)(Sem: 1-2)

MATH 250(3)[1] or MATH 251(4)[1] (Sem: 3-4)

**REQUIREMENTS FOR THE OPTION:** 50-51 credits

**ACTUARIAL MATHEMATICS OPTION:** (50-51 credits)

**PRESCRIBED COURSES** (30 credits)[1]

I E 425(3), MATH 414(3), MATH 415(3), MATH 416(3), MATH 484(3), R M 302(3), R M 410(3), R M 411(3), R M 412(3), STAT 462(3) (Sem: 5-8)

**ADDITIONAL COURSES** (6 credits)[1]

MATH 451(3) or MATH 486(3) (Sem: 5-8)

Select 3 credits from STAT 463 or 400-level MATH courses except MATH 401(3), MATH 405(3), MATH 406(3), MATH 441(3), MATH 470(3), MATH 471(4) (Sem: 5-8)

**SUPPORTING COURSES AND RELATED AREAS** (14-15 credits)

Select 14-15 credits from department list (Sem: 1-8)

**APPLIED AND INDUSTRIAL MATHEMATICS OPTION:** (50-51 credits)

**PRESCRIBED COURSES** (21 credits)[1]

MATH 403(3), MATH 412(3), MATH 414(3), MATH 415(3), MATH 436(3), MATH 450(3), MATH 455(3) (Sem: 5-8)

**ADDITIONAL COURSES** (12 credits)[1]

Select 12 credits from MATH 411(3), MATH 416(3), MATH 417(3), MATH 419(3), MATH 421(3), MATH 456(3), MATH 461(3), MATH 467(3), MATH 468(3), MATH 479(3), MATH 484(3), MATH 485(3), MATH 486(3) (Sem: 5-8)

**SUPPORTING COURSES AND RELATED AREAS** (17-18 credits)

Select 17-18 credits from department list (Sem: 1-8)

**COMPUTATIONAL MATHEMATICS OPTION:** (50-51 credits)

**PRESCRIBED COURSES** (24 credits)

CMPSC 122(3) (Sem: 3-4)

CMPSC 465(3), MATH 414(3)[1], MATH 415(3)[1], MATH 455(3)[1], MATH 456(3)[1], MATH 467(3)[1], MATH

484(3)[1] (Sem: 5-8)

**ADDITIONAL COURSES** (9 credits)[1]

Select 3 credits from MATH 411(3), MATH 412(3), or MATH 417(3) (Sem: 5-8)

Select 6 credits from CMPSC 468(3), MATH 310(3), MATH 468(3), or MATH 485(3) (Sem: 5-8)

**SUPPORTING COURSES AND RELATED AREAS** (17-18 credits)

Select 17-18 credits from department list (Sem: 1-8)

**GENERAL MATHEMATICS OPTION:** (50-51 credits)

**PRESCRIBED COURSE** (9 credits)[1]

MATH 403(3), MATH 414(3), MATH 415(3) (Sem: 5-8)

**ADDITIONAL COURSES** (12 credits)[1]

MATH 435(3) or MATH 436(3) (Sem: 5-8)

Select 3 credits from MATH 411(3), MATH 412(3), MATH 417(3), MATH 419(3), or MATH 421(3) (Sem: 5-8)

Select 6 credits of 400-level MATH courses except MATH 401(3), MATH 405(3), MATH 406(3), MATH 441(3), MATH 470(3), MATH 471(4) (Sem: 5-8)

**SUPPORTING COURSES AND RELATED AREAS** (29-30 credits)

Select an approved sequence of 12 credits in MATH or a related area or an area of application (Sem: 1-8)

Select 17-18 credits from department list (Sem: 1-8)

**GRADUATE STUDY OPTION:** (50-51 credits)

**PRESCRIBED COURSES** (24 credits)[1]

MATH 403(3), MATH 404(3), MATH 414(3), MATH 415(3), MATH 421(3), MATH 429(3), MATH 435(3), MATH 436(3) (Sem: 5-8)

**ADDITIONAL COURSES** (9 credits)[1]

Select 9 credits of 400-level MATH courses except MATH 401(3), MATH 405(3), MATH 406(3), MATH 441(3), MATH 470(3), MATH 471(4) (Sem: 5-8)

**SUPPORTING COURSES AND RELATED AREAS** (17-18 credits)

Select 17-18 credits from department list (Sem: 1-8)

**SYSTEMS ANALYSIS OPTION:** (50-51 credits)

**PRESCRIBED COURSES** (12 credits)[1]

MATH 414(3), MATH 415(3), MATH 436(3), MATH 484(3) (Sem: 5-8)

**ADDITIONAL COURSES** (9 credits)[1]

Select 6 credits from MATH 310(3), MATH 451(3), MATH 485(3), or MATH 486(3) (Sem: 5-8)

Select 3 credits from 400-level MATH courses except MATH 401(3), MATH 405(3), MATH 406(3), MATH 441(3), MATH 470(3), MATH 471(4) (Sem: 5-8)

**SUPPORTING COURSES AND RELATED AREAS** (29-30 credits)

Select an approved sequence of 12 credits in an area of application; possible areas include business, economics, industrial engineering, social sciences (Sem: 1-8)

Select 17-18 credits from department list (Sem: 1-8)

**Integrated B.S. in Mathematics and Master of Applied Statistics (M.A.S.)**

The Integrated Undergraduate-Graduate (IUG) degree with B.S. in Mathematics and Master of Applied Statistics (M.A.S.) is designed to be completed in five years. This integrated degree will enable a select number of highly qualified and career oriented students to obtain training in statistics focused on developing data analysis skills, and exploration of core areas of applied statistics at the graduate levels in addition to an undergraduate degree in Mathematics. The M.A.S. degree is a professional masters degree that emphasizes applications. The degree prepares students with interests in mathematics, computation, and the quantitative aspects of science for careers in industry and government as statistical analysts. Research divisions in the pharmaceutical industry, quality control, and quality engineering divisions in manufacturing companies, clinical research units, corporate planning and research units, and other data intensive positions require persons with training in mathematics, computation, database management, and statistical analysis, which this program will provide.

**Application Process**

The number of openings in the integrated B.S. in Mathematics and M.A.S. program is limited. Admission will be based on specific criteria and the recommendation of faculty. Applicants to the integrated program:

Must be enrolled in the Mathematics B.S. program.

Must have completed at least 60 credits of the undergraduate degree program including the two courses: STAT 414 and STAT 415 and the students must apply to the integrated program prior to completing 110 credits.

Must submit a transcript and a statement of purpose.

Must present a departmental approved plan of study in the application process in consultation with the M.A.S. program director.

Must be recommended by the chair of Mathematics Department's undergraduate program committee. Two additional recommendation letters must be sent to the M.A.S. admissions committee.

Must submit the GRE to the M.A.S. admissions committee.

Must apply to the M.A.S. program in Statistics.

For the IUG B.S. in Mathematics and M.A.S. degree, 120 credits are required for the B.S. and 30 credits for the M.A.S. The following twelve graduate level credits (number of credits in parentheses) can apply to both B.S. and M.A.S. degrees, six of these are at the 500 level: STAT 414(3), STAT 415(3), STAT 501(3), STAT 502(3).

Assuming all requirements for the B.S. in Mathematics are completed, students in the program can complete the B.S. degree and not advance to the M.A.S. degree if they desire.

### **Degree Requirements**

IUG Math B.S. students must fulfill the Math B.S. requirement while counting these prescribed Statistics courses (15 credits)

STAT 220(3)\*, STAT 414(3), STAT 415(3), STAT 501(3), STAT 502(3)

**IUG M.A.S. Requirements** (30 credits)

STAT 414(3), STAT 415(3), STAT 501(3), STAT 502(3), STAT 580(2) and STAT 581(1)\*\*

**Electives:** (15 credits)

Select from STAT 464(3), STAT 503(3), STAT 504(3), STAT 505(3), STAT 506(3), STAT 507(3), STAT 508(3), STAT 509(3), STAT 510(3) and the departmental list of additional courses for the M.A.S. program with the approval of the adviser.

For the IUG B.S. in Mathematics and M.A.S. degree, the four courses: STAT 414(3), STAT 415(3), STAT 501(3) and STAT 502(3) can apply to both the B.S. and M.A.S. degrees.

## **Integrated B.S. in Mathematics/M.Ed. in Curriculum and Instruction**

The Mathematics and Curriculum and Instruction with emphasis in Mathematics Education Integrated Undergraduate-Graduate (MATH/CI-MTHED IUG) leading to teacher certification in Mathematics Grades 7-12.

The Mathematics and Curriculum Instruction with Emphasis in Mathematics Education Integrated Undergraduate-Graduate (MATH/CI-MTHED IUG) Degree Program consists of the integration of required courses for a B.S. in Mathematics Systems Analysis Option, a M.Ed. in Curriculum and Instruction with emphasis in Mathematics Education (MTHED), and Pennsylvania certification for Mathematics Grades 7-12.

The MATH/CI-MTHED IUG is a five-year program for highly qualified students seeking to teach mathematics at the secondary level. A hallmark of the program is its strong statistics strand in addition to its mathematics core. In addition to developing advanced understanding of mathematics and statistics, students will learn how to develop and implement lessons and to incorporate technology and research in instruction designed to reach all students.

Students are expected to complete courses required for the certification program integrated with their undergraduate and graduate experiences and will likely complete one summer in residence. Completion of the IUG (along with earning a passing score on the Pennsylvania Department of Education required PRAXIS test) leads to a B.S. in Mathematics, certification in Mathematics Grades 7-12, and a M.Ed. in Curriculum and Instruction.

Admission to the MATH/CI-MTHED IUG Mathematics Grades 7-12 program will be based upon having

attained a minimum GPA of 3.5 after completing at least 60 credits of the program, with a grade of C or better in all courses. Admission will be based on a recommendation by the Mathematics Department in consultation with the Mathematics Education faculty in the Department of Curriculum and Instruction.

For the B.S./M.Ed. Degree in integrated Mathematics B.S. and Curriculum and Instruction M.Ed., 129 credits are required for the B.S. degree, 30 credits are required for the M.Ed., and 41 credits are required for field experiences and additional courses required for secondary mathematics certification in Pennsylvania. The following courses can be used in both the B.S. and the M.Ed. degrees: MATH 400-level electives, STAT 501, STAT 502. Students can complete the B.S. in Mathematics and not advance to the M.Ed. Curriculum and Instruction degree if they desire.

## Master of Education

CURRICULUM AND INSTRUCTION M.Ed. (31 credits)  
(IUG in Mathematics/Curriculum and Instruction)

Core Areas (9 credits - choose one course from each area): ?Curriculum: C I 550 or equivalent;

Research: STAT 500 or equivalent; ?Learning: EDPSY 421 or equivalent

Emphasis in Mathematics Education (\* denotes required courses)? includes \*C I 590; \*STAT 501; MATH 485, MATH 486, or MATH/CMPSC 451; \*MTHED 511 or equivalent; \*MTHED 520; at least one additional 400-level MATH course other than 401, 405, 406, 441, 470, or 471; at least one additional 400- or 500-level MTHED course.

Note: A Master's paper is required for completion of the M.Ed.

A passing score on the PRAXIS Mathematics Content Exam is required for Mathematics Grades 7-12 certification.

\*Can be waived for students with an equivalent course, e.g. STAT 250 GQ(3) or STAT 301 GQ(3).

\*\* For all students in the M.A.S. program, the STAT 581(1) course will have a comprehensive written project report required as part of the course, which serves as the culminating experience.

**[1]** A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

Last Revised by the Department: Fall Semester 2016

Blue Sheet Item #: 45-01-135

Review Date: 08/23/2016

UCA Revision #1: 8/16/06

UCA Revision #2: 7/30/07

SC

## Microbiology

*University Park, Eberly College of Science (MICRB)*

PROFESSOR Meredith Rosser Defelice, *in charge*

Microbiology is the science of the "simple" forms of life and of the response of more complex life forms to their presence and activities. Students in the Microbiology major will (1) complete a comprehensive study of life processes at the molecular and cellular level, with particular emphasis on prokaryotes, and (2) perform basic and advanced techniques in laboratory methodology. Through advanced course study, the many subdisciplines of microbiology such as molecular genetics, immunology, and virology may be explored more fully. Ample opportunities exist for participation in faculty-initiated research projects. Extensive laboratory experience is a particular strength of the major. Courses in such applied areas as industrial, medical, and food microbiology help prepare students for careers in the pharmaceutical, biotechnical, and agricultural industries.

In order to be eligible for entrance to the Microbiology major, a student must have: (1) attained at least a 2.00 cumulative grade-point average and (2) completed CHEM 110 GN(3), CHEM 111 GN(1), CHEM 112 GN(3), and MATH 140 GQ(4) and earned a grade of C or better in each of these courses.

For the B.S. degree in Microbiology, a minimum of 125 credits is required.

*Scheduling Recommendation by Semester Standing given like (Sem: 1-2)*

**GENERAL EDUCATION:** 45 credits

(15 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)

(See description of General Education in this bulletin.)

**FIRST-YEAR SEMINAR:**

(Included in REQUIREMENTS FOR THE MAJOR)

**UNITED STATES CULTURES AND INTERNATIONAL CULTURES:**

(Included in GENERAL EDUCATION course selection)

**WRITING ACROSS THE CURRICULUM:**

(Included in REQUIREMENTS FOR THE MAJOR)

**REQUIREMENTS FOR THE MAJOR:** 95 credits[86]

(This includes 15 credits of General Education courses: 9 credits of GN courses; 6 credits of GQ courses.)

**PRESCRIBED COURSES** (64 credits)

CHEM 110 GN(3)[11], CHEM 111 GN(1)[11], CHEM 112 GN(3)[11], CHEM 113 GN(1), MATH 140 GQ(4)[11], MATH 141 GQ(4), MICRB 201(3)[85], MICRB 202(2), PSU 16(1) (Sem: 1-2)

PHYS 250 GN(4), PHYS 251 GN(4) (Sem: 1-4)

BMB 442(3), BIOL 322(3), CHEM 210(3), CHEM 212(3), CHEM 213(2), MICRB 251(3)[85], MICRB 252(3)[85] (Sem: 3-4)

BMB 400(2), BMB 401(3), BMB 402(3), MICRB 421(3) (Sem: 5-6)

BMB 428(3) (Sem: 5-8)

**ADDITIONAL COURSES** (21-23 credits)

Select any four of the following: MICRB 401(3), MICRB 410(3), MICRB 412(3), MICRB 415(3), or MICRB 450(2) (Sem: 5-6)

Select 3-4 credits from BMB 445(2), BMB 448(2), MICRB 422(2), MICRB 447(1) (Sem: 5-8)

Select 6-7 credits from FDSC 408(2), BMB 408(1-2), BMB 488(2), BMB 496(1-18) or any other MICRB 400-level course, with a total maximum of 3 credits in BMB 408 and/or MICRB 408 and a maximum of 4 credits in BMB 488 and/or BMB 496 (1-18) (Sem: 5-8)

**SUPPORTING COURSES AND RELATED AREAS** (8-10 credits)

Select 8-10 credits from department list (Sem: 5-8)

*Note:* A student enrolled in an ROTC program may, after consultation with the head of the microbiology program, substitute up to 6 credits of ROTC in the categories of Additional Courses and Supporting Courses and Related Areas.

**[1]** A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

**[85]** To graduate, a grade of C or better is required in two of the following courses: MICRB 201, BMB/MICRB 251, BMB/MICRB 252.

**[86]** To graduate, a grade of C or better is required in 9 credits of any BMB, or MICRB 400-level course except BMB 443, BMB 445, BMB 448, BMB 488, BMB 496, MICRB 421, MICRB 422, MICRB 442, MICRB 447.

Last Revised by the Department: Fall Semester 2016

Blue Sheet Item #: 45-01-136

Review Date: 08/23/16

UCA Revision #1: 8/9/06

SC

## Physics

*University Park, Eberly College of Science (PHYS)*

PROFESSOR NITIN SAMARTH, *George A. and Margaret M. Downsborough Department Head*

This major provides a sound program of technical and general education for students planning a career in physics and related fields. The General option provides broad coverage with the most physics and mathematics course requirements and is useful for students intending to pursue graduate study in Physics or similar disciplines. The Medical and Electronics options incorporate coursework in support of the



application of physics and mathematics in various life-science or engineering related fields. A Computation option provides background in the application of physical principles and mathematical methods in the solution of scientific problems, simulations, or visualizations using computer and numerical techniques. The Nanotechnology/Material Science option provides students with background in the understanding of condensed matter physics at either the nano- or micro/macro- levels.

In order to be eligible for entrance to the Physics major, a student must have: 1) attained at least a 2.00 cumulative grade-point average; 2) completed CHEM 110 GN(3), MATH 140 GQ(4), MATH 141 GQ(4), PHYS 211 GN(4), and PHYS 212 GN(4), and earned a grade of C or better in each of these courses.

### **TO VIEW THE Physics Minor (PHYS)**

For the B.S. degree in Physics, a minimum of 120 credits is required.

*Scheduling Recommendation by Semester Standing given like (Sem: 1-2)*

#### **GENERAL EDUCATION: 45 credits**

(18 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)  
(See description of General Education in front of *Bulletin*.)

#### **FIRST-YEAR SEMINAR:**

(Included in GENERAL EDUCATION course selection)

#### **UNITED STATES CULTURES AND INTERNATIONAL CULTURES:**

(Included in GENERAL EDUCATION course selection)

#### **WRITING ACROSS THE CURRICULUM:**

(Included in REQUIREMENTS FOR THE MAJOR)

#### **REQUIREMENTS FOR THE MAJOR: 93-96 credits**

(This includes 18 credits of General Education courses: 9 credits of GN courses; 6 credits of GQ courses; 3 credits of GWS courses.)

#### **COMMON REQUIREMENTS FOR THE MAJOR (ALL OPTIONS): 69 credits**

##### **PRESCRIBED COURSES (59 credits)**

CHEM 110 GN(3)[1], CHEM 111 GN(1), CHEM 112 GN(3), CHEM 113 GN(1), MATH 140 GQ(4)[1], MATH 141 GQ(4)[1] (Sem: 1-2)

PHYS 211 GN(4)[1], PHYS 212 GN(4)[1], PHYS 213 GN(2)[1], PHYS 214 GN(2)[1], PHYS 237(3)[1] (Sem: 1-4)  
ENGL 202C GWS(3), MATH 220 GQ(2), MATH 251(4)[1] (Sem: 3-4)

PHYS 400(4)[1], PHYS 410(4)[1], PHYS 419(3)[1], PHYS 420(3)[1], PHYS 444(2)[1], PHYS 457W(3)[1] (Sem: 5-8)

##### **ADDITIONAL COURSES (7 credits)**

MATH 230(4)[1], or MATH 231(2)[1] and MATH 232(2)[1] (Sem: 3-4)

CMPSC 101 GQ(3) or CMPSC 121 GQ(3) or CMPSC 200 GQ(3) or CMPSC 201 GQ(3) or CMPSC 202 GQ(3)  
(Sem: 3-4)

##### **SUPPORTING COURSES AND RELATED AREAS (3 credits)**

Take 3 credits of 400-level MATH from departmental list (Sem: 7-8)

#### **REQUIREMENTS FOR THE OPTION: 24-27 credits**

##### **COMPUTATION OPTION: (24 credits)**

##### **PRESCRIBED COURSES (9 credits)**

CMPSC 122(3) (Sem: 3-4) (Note: CMPSC 122 has CMPSC 121 as a pre-requisite, so care should be taken when choosing the 'programming requirement' under the Common Requirements for the major.)

MATH 455(3), MATH 456(3) (Sem: 5-6)

##### **SUPPORTING COURSES AND RELATED AREAS (15 credits)**

Select 6 credits from program list (Sem: 3-6)

Select 3 credits of natural science (GN) courses that are not listed in the major (Sem: 5-6)

Take a total of 6 credits from AERSP 424(3), 300-400-level CMPSC, 400-level MATH from departmental list or 400-level STAT (Sem: 5-8)

##### **ELECTRONICS OPTION: (27 credits)**

##### **PRESCRIBED COURSES (4 credits)**

EE 210(4) (Sem: 3-6)

##### **ADDITIONAL COURSES (8 credits)**

Select 2 of the following 3: EE 310(4), EE 350(4), CMPEN 270(4) (Sem: 4-6)

**SUPPORTING COURSES AND RELATED AREAS** (15 credits)

Select 6 credits from program list (Sem: 3-6)

Select 3 credits of natural science (GN) courses that are not listed in the major (Sem: 5-6)

Take 6 credits of E E 3XX or 4XX level courses (Sem: 5-8)

**GENERAL PHYSICS OPTION:** (25-26 credits)

**ADDITIONAL COURSES** (10-11 credits)

Select 6-7 credits from items a, b, and/or c (Sem: 7-8)

a. PHYS 406(3), PHYS 411(3), PHYS 412(3), PHYS 413(3), PHYS 443(3), PHYS 461(3), PHYS 479(3), PHYS 496(3) or PHYS 497(3)

b. PHYS 402(4) or PHYS 458(4) (the course not selected below may be used)

c. ASTRO 410(3), ASTRO 440(3), or ASTRO 485(3) (only 3 credits of ASTRO courses may be used)

Select 4 credits from PHYS 402(4) or PHYS 458(4) (Sem: 7-8)

**SUPPORTING COURSES AND RELATED AREAS** (15 credits)

Select 3 credits of natural science (GN) courses that are not listed in the major (Sem: 3-8)

Select 9 credits from program list; a maximum of 6 of the 12 credits may be from PHYS 496(1-18), SC 295(1-9), SC 395(1-9), or SC 495(1-9) (Sem: 3-8)

Select 3 credits of 4XX-level MATH from program list (Sem: 7-8)

**MEDICAL PHYSICS OPTION:** (24-25 credits)

This option prepares students for graduate study in medical physics, medical school, or bioengineering. The courses in option (b) below help satisfy the requirements for a minor in Bioengineering. Application for the BIOE minor must be made to the Department of Bioengineering.

**ADDITIONAL COURSES** (15-16 credits)

Select from the following two sets of courses:

(a) BIOL 110 GN(4), and BIOL 240W GN(4), CHEM 210(2), CHEM 212(3), CHEM 213(3) (Sem: 3-8)

(b) BMB 251(3) or BIOL 230W GN(4) or BME 201(3); BIOL 141 GN(3) or BIOL 472(3); 9 credits of BIOE at the 300 or 400 level (Sem: 3-8)

**SUPPORTING COURSES AND RELATED AREAS** (9 credits)

Select 9 credits from program list; a maximum of 6 of the 9 credits may be from PHYS 496(1-18), SC 295(1-9), SC 395(1-9) or SC 495(1-9) (Sem: 5-8)

**NANOTECHNOLOGY/MATERIAL SCIENCE OPTION:** (24-25 credits)

**PRESCRIBED COURSES** (3 credits)

PHYS 412(3) (Sem: 7)

**ADDITIONAL COURSES** (12-13 credits)

The courses in option (a) help satisfy the requirements for the Nanotechnology minor.

Select from the following two sets of courses:

(a) ESC 312(3), ESC 313(3) and select 6 credits from ESC 400-level courses

(b) MATSE 201(3), MATSE 430(3), MATSE 460(1); MATSE 402(3) or MATSE 436(3); select 3 credits from MATSE 400-level courses (Sem: 5-8)

**SUPPORTING COURSES AND RELATED AREAS** (9 credits)

Select 6 credits from program list (Sem: 3-6)

Select 3 credits of natural science (GN) courses that are not listed in the major (Sem: 5-6)

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

Last Revised by the Department: Spring Semester 2013

Blue Sheet Item #: 41-06-096

Review Date: 04/09/2013

**Comments**

SC

## Planetary Science and Astronomy

University Park, Eberly College of Science (PASTR)

Professor Donald Schneider, Chair

Planetary Science and Astronomy majors will study the Earth system in the context of the Solar System and the universe as a whole. Students will apply methods and knowledge from mathematics, geosciences, chemistry, biology, astronomy and physics, and through laboratory experiences and coursework they will both learn to explore the Earth and to use telescopes to obtain astronomical data. They will study planetary systems around other stars and explore the possibility of their harboring life. Communication of these topics, both oral and written, to the public and to their peers will be emphasized, as will logic and general problem-solving skills. Upon graduation students will be prepared to enter a graduate program in education to obtain teaching certification, to work in an informal science venue or planetarium, or to enter a variety of industry, environmental, or defense professions.

In order to be eligible for entrance to the Planetary Science and Astronomy major, a student must have: 1) Attained at least a 2.00 cumulative grade-point average; 2) Completed Math 140 with a grade of C or better; 3) Completed at least four of the following courses with a grade of C or better: ASTRO 120, ASTRO 130, ASTRO 140, BIOL 110, CHEM 110, EARTH 2, GEOSC 1, GEOSC 20, or STAT 200.

A minimum of 122 credits is required to earn the degree.

*Scheduling Recommendation by Semester Standing given like (Sem: 1-2)*

**GENERAL EDUCATION:** 45 credits

(18 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)  
(See description of General Education in front of the Bulletin)

**FIRST-YEAR SEMINAR:**

(Included in General Education course selection)

**UNITED STATES CULTURES AND INTERNATIONAL CULTURES:**

(Included in General Education course selection)

**WRITING ACROSS THE CURRICULUM:**

(Included in General Education course selection or REQUIREMENTS FOR THE MAJOR)

**REQUIREMENTS FOR THE MAJOR:** 95-99 credits

(This includes 18 credits of General Education courses: 9 credits of GN courses; 6 credits of GQ courses; 3 credits of GWS courses)

**PRESCRIBED COURSES:** 37 credits

BIOL 110 GN(4)[1], CHEM 110 GN(3)[1], CHEM 111 GN(1), CHEM 112 GN(3)[1], CHEM 113 GN(1), ENGL 202C GWS(3), MATH 140 GQ(4)[1], MATH 141 GQ(4) (Sem: 1-4)  
ASTRO 401(4)[1], ASTRO 402(3)[1], BIOL/GEOSC 474(3)[1], STAT 200 GQ(4)[1] (Sem: 5-8)

**ADDITIONAL COURSES:** 38-39 credits

Select 3 credits from ASTRO 1 GN(3), ASTRO 5 GN(3), ASTRO 6 GN(3), ASTRO 291 GN(3) (Sem: 1-4)

Select 3-4 credits from CMPSC 101 GQ(3), CMPSC 121 GQ(3), CMPSC 201 GQ(3), CMPSC 202 GQ(3), CMPSC 203 GQ(4) (Sem: 1-6)

Select 9 credits from ASTRO 120 GN(3), ASTRO 130 GN(3), ASTRO 140 GN(3), ASTRO 292 GN(3) (Sem: 1-6)

Select 3 credits from EARTH 2 GN(3), GEOSC 1(3), GEOSC 20 GN(3) (Sem: 1-4)

PHYS 211 GN(4) or PHYS 250 GN(4) (Sem: 3-6)

PHYS 212 GN(4) or PHYS 251 GN(4) (Sem: 3-6)

Select 12 credits from EARTH 100 GN(3), EARTH 103 GN(3), EARTH 106 GN(3), EARTH 150 GN(3), EARTH 202(3), GEOG 160 GS(3), GEOSC 201(4), GEOSC 202(4), GEOSC 203(4), GEOSC 204(4), METEO 101 GN(3), METEO 201(3) (Sem: 3-8)

**SUPPORTING COURSES AND RELATED AREAS:** 20-23 credits

At least 6 credits from the below categories must be at the 400 level

Select 11 credits in consultation with adviser from department list (Sem: 1-8)

Select 9-12 credits from program list of advanced electives (Sem: 3-8)

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44

Last Revised by the Department: Spring Semester 2013

Blue Sheet Item #: 41-05-146

Review Date: 02/19/2013

# Premedical-Medical

University Park, Eberly College of Science (P M M)

PROFESSOR RONALD A. MARKLE, *in charge*

This is a special accelerated program in cooperation with the Sydney Kimmel Medical College (SKMC) at Thomas Jefferson University in Philadelphia whereby exceptional students have the opportunity to earn both the B.S. and M.D. degrees in seven years. Students are selected for this program while they are seniors in high school and must begin their undergraduate studies the fall immediately following their graduation. The first three years of the program are completed at University Park and the next four at SKMC Jefferson. The Penn State B.S. degree in Premedical-Medical is awarded after completion of 96 Penn State credits and successful completion of the first year of the standard curriculum at SKMC Jefferson Medical College.

*Scheduling Recommendation by Semester Standing given like (Sem: 1-2)*

**GENERAL EDUCATION:** 45 credits

(15 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)  
(See description of General Education in this bulletin.)

**FIRST-YEAR SEMINAR:**

(Included in ELECTIVES or GENERAL EDUCATION course selection)

**UNITED STATES CULTURES AND INTERNATIONAL CULTURES:**

(Included in GENERAL EDUCATION course selection)

**WRITING ACROSS THE CURRICULUM:**

(Included in GENERAL EDUCATION course selection)

**ELECTIVES:** 0-1 credit

**REQUIREMENTS FOR THE MAJOR:** 64-66 credits

(This includes 15 credits of General Education courses; 9 credits of GN courses; 6 credits of GQ courses.)

**PRESCRIBED COURSES** (46 credits)

CHEM 110 GN(3)[1], CHEM 111 GN(1)[1], CHEM 112 GN(3)[1], CHEM 113 GN(1)[1], MATH 140 GQ(4)[1],  
MATH 141 GQ(4)[1] (Sem: 1-2)

CHEM 210(3), CHEM 212(3), CHEM 213(2), PHYS 211 GN(4), PHYS 212 GN(4), PHYS 213 GN(2), PHYS 214  
GN(2) (Sem: 3-4)

BMB 401(3)[1], BMB 402(3)[1], BIOL 110 GN(4)[1] (Sem: 5-6)

**SUPPORTING COURSES AND RELATED AREAS** (10-20 credits)

Select 4-5 credits of life science with lab (Sem: 1-6)

Select 3 credits from program list (Sem: 1-6)

0-8 credits in a foreign language (proficiency demonstrated by examination or course work to the level of the second semester; if fewer than 8 credits are needed to reach the required proficiency, students choose selections from program list to total 8 credits) (Sem: 1-6)

Select 3-4 credits of life science (Sem: 3-6)

*Note:* Depending on advanced placement credit and schedule load, it might also be necessary to enroll during one of the other summer sessions before entering SKMC Jefferson Medical College at semester seven.

**[1]** A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

Last Revised by the Department: Spring Semester 2015

Blue Sheet Item #: 43-06-000

Review Date: 04/14/2015

UCA Revision #1: 8/9/06

SC

Publications updated faculty in charge: 7/17/09

## Premedicine

University Park, Eberly College of Science (P M)

PROFESSOR RONALD A. MARKLE, *in charge*

This major provides a broad foundation necessary to the understanding of the basic subjects of modern medical studies. The curriculum, which offers a good balance between science and nonscience courses, constitutes an excellent preparation for admission to medical school. It also gives students the freedom to tailor the program to meet their individual needs by permitting a generous number of supporting courses. Specific admission requirements or recommendations of a particular medical school, not already in the required courses of the major, may be included among the supporting courses. Many students also use their supporting courses to pursue a minor.

In order to be eligible for entrance to the Premedicine major, a student must have: 1) attained at least a 3.20 cumulative grade-point average; and 2) completed BIOL 110 GN(4), BIOL 230W GN(4), CHEM 110 GN(3), CHEM 111 GN(1), CHEM 112 GN(3), CHEM 113 GN(1), CHEM 210(3), MATH 140 GQ(4), MATH 141 GQ(4) and earned a grade of C or better in each of these courses.

**THREE-YEAR ALTERNATIVE:** A student may also become eligible for the Bachelor of Science degree in this major upon satisfactory completion of:

- a. A total of 96 credits, including General Education credits in Writing/Speaking, Health Sciences and Physical Education, and Arts, Humanities, and Social and Behavioral Sciences; 8 credits in a single foreign language; BIOL 110 GN(4), BIOL 230W GN(4); CHEM 110 GN(3), CHEM 111 GN(1), CHEM 112 GN(3), CHEM 113 GN(1), CHEM 210(3) [1], CHEM 212(3) [1], CHEM 213(2) [1]; MATH 140 GQ(4), MATH 141 GQ(4); PHYS 211 GN(4) [1], PHYS 212 GN(4) [1], PHYS 213 GN(2) [1] and PHYS 214 GN(2) [1].
- b. The first year of an accredited medical or dental postgraduate program.

For the B.S. degree in Premedicine, a minimum of 126 credits is required, with at least 18 credits at the 400 level.

*Scheduling Recommendation by Semester Standing given like (Sem: 1-2)*

**GENERAL EDUCATION:** 45 credits

(24 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)

(See description of General Education in this bulletin.)

**FIRST-YEAR SEMINAR:**

(Included in GENERAL EDUCATION course selection or REQUIREMENTS FOR THE MAJOR)

**UNITED STATES CULTURES AND INTERNATIONAL CULTURES:**

(Included in REQUIREMENTS FOR THE MAJOR)

**WRITING ACROSS THE CURRICULUM:**

(Included in REQUIREMENTS FOR THE MAJOR)

**REQUIREMENTS FOR THE MAJOR:** 105 credits

(This includes 24 credits of General Education courses: 9 credits of GN courses; 6 credits of GQ courses; 6 credits of GS courses; 3 credits of GHA courses.)

**PRESCRIBED COURSES** (59 credits)

BIOL 110 GN(4) [1], BIOL 230W GN(4) [1], CHEM 110 GN(3) [1], CHEM 111 GN(1) [1], CHEM 112 GN(3) [1], CHEM 113 GN(1) [1], MATH 140 GQ(4) [1], MATH 141 GQ(4) [1], NUTR 251 GHA(3) [1] (Sem: 1-2)

HPA 101(3), PHIL 432(3), PSYCH 100 GS(3), SOC 1 GS(3) (Sem: 1-6)

CHEM 210(3) [1], CHEM 212(3) [1], CHEM 213(2) [1] (Sem: 3-4)

PHYS 211 GN(4) [1], PHYS 212 GN(4) [1], PHYS 213 GN(2) [1], and PHYS 214 GN(2) [1] (Sem: 3-6)

**ADDITIONAL COURSES** (16-20 credits)

Select 4-5 credits from BIOL 220W GN(4), BIOL 240W GN(4), MICRB 201(3)/MICRB 202(2) (Sem: 3-8)

Select 3-4 credits from STAT 200 GQ(4) or STAT 250 GQ(3) (Sem: 3-8)

Select 4-5 credits [1] from BIOL 421(4); BIOL 437(4); BIOL 472(3) and BIOL 473(2); MICRB 412(3) and MICRB 422(2) (Sem: 5-8)

Select 5-6 credits [1] from BMB 400(2-3), BMB 401(3), BMB 402(3) (Sem: 5-8)

**SUPPORTING COURSES AND RELATED AREAS** (26-30 credits)

Select 0-8 credits in a foreign language (proficiency demonstrated by examination or course work to the level of the second semester; if fewer than 8 credits are needed to reach the required proficiency, students choose selections from program list to total 8 credits) (Sem: 1-8)

Select 18-30 credits from program list (A maximum of 12 credits of Independent Study [296, 496] may be applied toward credits for graduation. Students may apply 6 credits of ROTC.) (Sem: 1-8)

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

Last Revised by the Department: Spring Semester 2015

Blue Sheet Item #: 43-06-000

Review Date: 04/14/2015

UCA Revision #1: 8/9/06

UCA Revision #2: 7/30/07

SC

Publications updated faculty in charge: 7/17/09

## Science

*Abington College (SCIAB)*

*Altoona College (SCIAL)*

*Berks College (SCIBL)*

*Capital College (SCICA)*

*University College (SCICC): Penn State Worthington-Scranton, Penn State York*

*University Park, Eberly College of Science (SC BS)*

*Integrated Five-Year Science/Business M.B.A. Program (SCBUS)*

Not all options are available at every campus. Contact the campus you are interested in attending to determine which options are offered.

PROFESSOR RONALD MARKLE, *in charge*

The Science major is an interdisciplinary degree that aims to provide a broad, general education in science. The bachelor of science (B.S.) curriculum is designed specifically for students who have education goals relating to scientific theory and practice and who require a high degree of flexibility to obtain their educational objectives. After completing foundation courses in calculus, chemistry, physics, and the life sciences, students will select additional science courses from designated areas. A large number of supporting credits permit students to readily include significant breadth or specialization into their undergraduate curriculum. Some examples include minors in business, computer and information science, education, kinesiology, or other fields. The degree allows students throughout the Commonwealth to become familiar with both the theory and the practice of science. It can help prepare students for various careers in pharmaceutical, biotechnical, chemical, medical, and agricultural industries. The degree can also be tailored to meet the specific requirements of professional programs such as medical, dental, or pharmacy schools. The General Science option of the B.S. Science degree allows for the most flexibility. Achievement in a more specialized set of goals can be met by selecting one of the other B.S. options offered: the Biological Sciences and Health Professions option, the Legal Studies, Government Service, Public Policy option, the Life Sciences option, the Mathematical Sciences option, or the Physical Sciences option. Not all of these options are available at all locations, and there are minor distinctions of the core curriculum at some locations, so see the Science program director at your College for further details.

In order to be eligible for entrance to the Science major, a student at any location must have: 1) attained at least a 2.00 cumulative grade-point average; 2) completed MATH 140 GQ(4) with a grade of C or better; 3) completed at least two of the following courses, BIOL 110 GN(4); CHEM 110 GN(3); PHYS 211 GN(4) or PHYS 250 GN(4), with a grade of C or better.

For the B.S. degree in Science, a minimum of 124 credits is required, with at least 15 credits at the 400 level.

**TWO-YEAR PREPROFESSIONAL PREPARATION:** The first two years of the Science major (62 credits) can meet the pre professional needs of those interested in admission to some schools of pharmacy, physical therapy, optometry, nursing, and physician assistant training. Successful students can then transfer after two years of undergraduate study to the professional school to which they are admitted. Note, however, that no Penn State degree can be awarded after only two years (62 credits) of study in the Science major. Also, note that the abbreviated two-year curriculum alone does not prepare students for admission to professional schools of general medicine, veterinary medicine, or dental medicine. Consult with your college's health sciences professional adviser for additional information.

**ACCELERATED SCIENCE B.S./M.B.A. PROGRAM:** Students admitted to this special cooperative program between the Eberly College of Science and The Smeal College of Business will be able to combine a Bachelor of Science degree in the Science major, with a Master of Business Administration degree. Highly motivated students, who enter the University with a sufficient number and proper distribution of AP credits, will have the opportunity to complete the requirements for both programs within five years. The B.S. degree in the Science major General Science option, will be conferred upon satisfactory completion of:

1. A minimum of 112 acceptable undergraduate credits, which must include:
  1. (24 credits) The University's General Education requirements in the areas of Writing and Speaking (9), Health and Physical Activity (3), Arts (6), Humanities (6). The University's General Education requirements in the areas of Quantification, Natural Sciences, and Social and Behavioral Sciences will be satisfied by course work listed under headings "c" and "f".)
  2. The University's First-Year Seminar, United States Cultures, International Cultures, and Writing Across the Curriculum requirements. (Note: These requirements may be double counted in order to satisfy other requirements in the program.)
  3. (52-57 credits) BIOL 110 GN(4), CHEM 110 GN(3), CHEM 111(1), CHEM 112 GN(3), CHEM 113 GN(1), CMPSC 203 GQ(4), MATH 140 GQ(4), MATH 141 GQ(4); 3-4 credits from STAT 200 GQ(4), or STAT 250 GQ(3) or STAT 301(3) or STAT 401(3); 8-12 credits from PHYS 211 GN(4), PHYS 212 GN(4), PHYS 213 GN(2), PHYS 214 GN(2), or PHYS 250 GN(4), PHYS 251 GN(4); 3 additional life science credits from B M B 211(3), B M B 251(3), or MICRB 201(3); and 14 additional credits of course work from the Eberly College of Science, with at least nine credits at the 400 level.
  4. (0-8 credits) Demonstration of second semester proficiency in a single foreign language.
  5. (3-9 credits) SC 295(1-3), SC 395(1-3), SC 495(1-3) (Note: Students must complete three Eberly College of Science Cooperative Education experiences, including at least one experience which is a full semester in length.)
  6. (10 credits) ECON 102 GS(3), ECON 104 GS(3), ACCTG 211(4)
  7. (4-23 credits) Supporting courses and related areas selected from the program list.
2. The first semester of course work in The Smeal College of Business M.B.A. program (i.e., a minimum of 12 graduate credits).

*Scheduling Recommendation by Semester Standing given like (Sem: 1-2)*

**GENERAL EDUCATION:** 45 credits

(15 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)

(See description of General Education in this bulletin.)

**FIRST-YEAR SEMINAR:**

(Included in GENERAL EDUCATION course selection or SUPPORTING COURSES AND RELATED AREAS)

**UNITED STATES CULTURES AND INTERNATIONAL CULTURES:**

(Included in GENERAL EDUCATION course selection or SUPPORTING COURSES AND RELATED AREAS)

**WRITING ACROSS THE CURRICULUM:**

(Included in GENERAL EDUCATION course selection or REQUIREMENTS FOR THE MAJOR or SUPPORTING COURSES AND RELATED AREAS)

**REQUIREMENTS FOR THE MAJOR:** 94 credits

(This includes 15 credits of General Education courses: 9 credits of GN courses; 6 credits of GQ courses.)

**COMMON REQUIREMENTS FOR MAJOR (All options)**

**PRESCRIBED COURSES (20 credits)**

CHEM 110 GN(3)[\[1\]](#), CHEM 111 GN(1), CHEM 112 GN(3), CHEM 113 GN(1), MATH 140 GQ(4)[\[1\]](#), MATH 141 GQ(4) (Sem: 1-2)

BIOL 110 GN(4)[\[1\]](#) (Sem: 1-4)

**REQUIREMENTS FOR THE OPTIONS:** 74 credits

**GENERAL SCIENCE OPTION:** (74 credits)

**ADDITIONAL COURSES (15-20 credits)**

Select 4 credits from BIOL 129 GN(4), BIOL 220W(4), BIOL 230W(4), BIOL 240W(4) or BIOL 141 GN(3) and BIOL 142(1) (Sem: 3-4)

Select 3-4 credits from STAT 200 GQ(4), or STAT 250 GQ(3) or STAT 301(3) or STAT 401(3) (Sem: 3-4)

Select 8-12 credits from PHYS 211 GN(4)[\[1\]](#), PHYS 212 GN(4), PHYS 213 GN(2), PHYS 214 GN(2); or PHYS 250 GN(4)[\[1\]](#), PHYS 251 GN(4) (Sem: 3-6)

**SUPPORTING COURSES AND RELATED AREAS (54-59 credits)**

(A maximum of 12 credits of Independent Study [296, 496] may be applied toward credits for graduation.)

Select 21-26 credits from program list (Students may apply 6 credits of ROTC.) (Sem: 1-8)

Select 3 credits from earth and mineral sciences (Sem: 3-8)

Select 18 credits in life, mathematical, or physical sciences, with at least 9 credits[\[1\]](#) at the 400 level[\[60\]](#) (Sem: 3-8)

Select 3 credits in Global, Social and Personal Awareness from department approved course list in

consultation with adviser (Sem: 3-8)

Select 3 credits in Teamwork and Interpersonal Communication from department approved course list in consultation with adviser (Sem: 3-8)

Select 6 credits of 400-level courses (Sem: 5-8)

### **BIOLOGICAL SCIENCES AND HEALTH PROFESSIONS OPTION: (74 credits)**

#### **PRESCRIBED COURSES (3 credits)**

H P A 101(3) (Sem: 3-6)

#### **ADDITIONAL COURSES (24-31 credits)**

Select 4 credits from BIOL 129 GN(4), BIOL 220W(4), BIOL 230W(4), BIOL 240W(4) or BIOL 141 GN(3) and BIOL 142(1) (Sem: 3-4)

Select 3-4 credits from STAT 200 GQ(4), or STAT 250 GQ(3) or STAT 301(3) or STAT 401(3) (Sem: 3-4)

Select 6-8 credits from CHEM 210(3), CHEM 212(3), CHEM 213(2) or CHEM 202(3), CHEM 203(3) (Sem: 3-6)

Select 3 credits from B M B 211(3), B M B 251(3), MICRB 201(3), BIOL 222(3), or BIOL 322(3) (Sem: 3-6)

Select 8-12 credits from PHYS 211 GN(4)[1], PHYS 212 GN(4), PHYS 213 GN(2), PHYS 214 GN(2); or PHYS 250 GN(4)[1], PHYS 251 GN(4) (Sem: 3-6)

#### **SUPPORTING COURSES AND RELATED AREAS (40-47 credits)**

(A maximum of 12 credits of Independent Study [296, 496] may be applied toward credits for graduation.)

Select 15 credits from program list for Healthcare/ Medicine/Ethical Competencies; 6 credits must be at the 400-level (Sem: 3-8) Select from department approved course list in consultation with adviser.

Select 10-17 credits from program list (Students may apply 6 credits of ROTC. (Sem: 1-8)

Select 3 credits in Global, Social and Personal Awareness from department approved course list in consultation with adviser (Sem: 3-8)

Select 3 credits in Teamwork and Interpersonal Communication from department approved course list in consultation with adviser (Sem: 3-8)

Select 9 credits[1] of 400-level B M B, BIOL, BIOTC, or MICRB courses (Sem: 5-8)

### **LEGAL STUDIES, GOVERNMENT SERVICE, PUBLIC POLICY OPTION (74 credits)**

#### **ADDITIONAL COURSES (15-20 credits)**

Select 4 credits from BIOL 129 GN(4), BIOL 220W(4), BIOL 230W(4), BIOL 240W(4) or BIOL 141 GN(3) and BIOL 142(1) (Sem: 3-4)

Select 3-4 credits from STAT 200 GQ(4), or STAT 250 GQ(3) or STAT 301(3) or STAT 401(3) (Sem: 3-4)

Select 8-12 credits from PHYS 211 GN(4)[1], PHYS 212 GN(4), PHYS 213 GN(2), PHYS 214 GN(2); or PHYS 250 GN(4)[1], PHYS 251 GN(4) (Sem: 3-6)

#### **SUPPORTING COURSES AND RELATED AREAS (54-59 credits)**

Select 12-17 credits from program list (Students may apply 6 credits of ROTC. (Sem: 1-8)

Select 18 credits in life, mathematical, or physical sciences, with at least 9 credits[1] at the 400 level[60] (Sem: 3-8)

Select 18 credits from program list for Legal Studies, Government Service, Public Policy; 6 credits must be at the 400-level (Sem: 3-8) Select from department approved course list in consultation with adviser.

Select 3 credits in Global, Social and Personal Awareness from department approved course list in consultation with adviser (Sem: 3-8)

Select 3 credits in Teamwork and Interpersonal Communication from department approved course list in consultation with adviser (Sem: 3-8)

### **LIFE SCIENCE OPTION: (74 credits)**

#### **ADDITIONAL COURSES (24-30 credits)**

Select 4 credits from BIOL 220W GN(4), BIOL 230W GN(4), BIOL 240W GN(4) (Sem: 3-4)

Select 3 credits from CMPSC 101 GQ(3), MATH 250(3), or STAT 250 GQ(3) (Sem: 3-4)

Select 3 credits from B M B 211(3), B M B 251(3), or MICRB 201(3) (Sem: 3-4)

CHEM 202(3), CHEM 203(3); or CHEM 210(3), CHEM 212(3), CHEM 213(2) (Sem: 3-6)

PHYS 211 GN(4)[1], PHYS 212 GN(4), PHYS 213 GN(2), PHYS 214 GN(2); or PHYS 250 GN(4)[1], PHYS 251 GN(4) (Sem: 3-6)

#### **SUPPORTING COURSES AND RELATED AREAS (44-50 credits)**

(A maximum of 12 credits of Independent Study [296, 496] may be applied toward credits for graduation.)

Select 23-29 credits from program list (Students may apply 6 credits of ROTC.) (Sem: 1-8)

Select 3 credits in Global Social and PErsonal Awareness

Select 3 credits in Teamwork and Interpersonal Communication

Select 6 credits of 400-level courses (Sem: 5-8)

Select 9 credits[1] of 400-level B M B, BIOL, BIOTC, or MICRB courses (Sem: 5-8)

### **MATHEMATICAL SCIENCE OPTION: (74 credits)**



**PRESCRIBED COURSES** (5-6 credits)

CMPSC 122(3), MATH 220 GQ(2-3) (Sem: 3-6)

**ADDITIONAL COURSES** (24-29 credits)

Select 3 credits from B M B 211(3), B M B 251(3), or MICRB 201(3) (Sem: 3-4)

CMPSC 121 GQ(3), CMPSC 201 GQ(3), or CMPSC 202 GQ(3) (Sem: 3-6)

MATH 230(4) or MATH 251(4) (Sem: 3-6)

CMPSC 360(3) or MATH 311W(3-4); STAT 301 GQ(3) or STAT 318(3) (Sem: 3-8)

PHYS 211 GN(4)[1], PHYS 212 GN(4), PHYS 213 GN(2), PHYS 214 GN(2); or PHYS 250 GN(4)[1], PHYS 251 GN(4) (Sem: 3-8)

**SUPPORTING COURSES AND RELATED AREAS** (39-45 credits)

(A maximum of 12 credits of Independent Study [296, 496] may be applied toward credits for graduation.)

Select 18-24 credits from program list (Students may apply 6 credits of ROTC.) (Sem: 1-8)

Select 9 credits[1] of 400-level CMPSC, CSE, MATH, or STAT courses (Sem: 5-8)

Select 6 credits of 400-level courses (Sem: 5-8)

Select 3 credits in Global, Social &amp; Personal Awareness

Select 3 credits in Teamwork &amp; Interpersonal Communication

**PHYSICAL SCIENCE OPTION:** (74 credits)**PRESCRIBED COURSES** (15 credits)

ASTRO 291 GN(3), PHYS 211 GN(4)[1], PHYS 212 GN(4), PHYS 213 GN(2), PHYS 214 GN(2) (Sem: 3-6)

**ADDITIONAL COURSES** (16-18 credits)

Select 3 credits from B M B 211(3), B M B 251(3), or MICRB 201(3) (Sem: 3-4)

CHEM 202(3), CHEM 203(3); or CHEM 210(3), CHEM 212(3), CHEM 213(2) (Sem: 3-6)

MATH 230(4) or MATH 251(4) (Sem: 3-6)

Select 3 credits from ASTRO 292 GN(3); E MCH 211(3); M E 300(3); or PHYS 237(3) (Sem: 3-8)

**SUPPORTING COURSES AND RELATED AREAS** (41-43 credits)

(A maximum of 12 credits of Independent Study [296, 496] may be applied toward credits for graduation.)

Select 20-22 credits from program list (Students may apply 6 credits of ROTC.) (Sem: 1-8)

Select 6 credits of 400-level courses (Sem: 5-8)

Select 9 credits[1] of 400-level ASTRO, CHEM, or PHYS courses (Sem: 5-8)

Select 3 credits in Global, Social &amp; Personal Awareness

Select 3 credits in Teamwork &amp; Interpersonal Communication

**[1]** A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.**[60]** Physical sciences include ASTRO, CHEM, PHYS; mathematical sciences include CMPSC, MATH, STAT; life sciences include BIOL, BIOTC, B M B, MICRB.

Last Revised by the Department: Fall Semester 2016

Blue Sheet Item #: 45-01-001

Review Date: 08/23/2016

UCA Revision #1: 9/1/06

UCA Revision #2: 7/730/07

SC

## Statistics

*University Park, Eberly College of Science (STAT)*PROFESSOR DAVID HUNTER, *Head, Department of Statistics*

This major helps prepare students with interests in mathematics, computation, and the quantitative aspects of science for careers in industry and government as statistical analysts, or for further graduate training in statistics. The major includes five options: An Actuarial Statistics Option for students interested in working as actuaries in the insurance or business fields; an Applied Statistics Option for students interested in a cross-disciplinary program, such as econometrics, or psychometrics; a Biostatistics Option for students interested in pursuing careers with pharmaceutical companies, research hospitals or other fields in which biological data is analyzed; a Graduate Study Option for students planning to go to graduate school in a statistics-related field; and a Statistics and Computing Option for students wishing to combine statistical expertise with programming skills.

In order to be eligible for entrance into the Statistics major, a student must have: 1) Attained at least a 2.00 cumulative grade point average. 2) Completed MATH 140 GQ(4) and MATH 141 GQ(4); and earned a grade of C or better in each of these courses.

For the B.S. degree in Statistics a minimum of 120 credits is required.

*Scheduling Recommendation by Semester Standing given like (Sem: 1-2)*

**GENERAL EDUCATION:** 45 credits

(6-15 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)

(See description of General Education in front of *Bulletin*.)

**FIRST-YEAR SEMINAR:**

(Included in ELECTIVES or GENERAL EDUCATION course selection)

**UNITED STATES CULTURES AND INTERNATIONAL CULTURES:**

(Included in GENERAL EDUCATION course selection)

**WRITING ACROSS THE CURRICULUM:**

(Included in GENERAL EDUCATION course selection or REQUIREMENTS FOR THE MAJOR)

**REQUIREMENTS FOR THE MAJOR:** 80-95 credits

(This includes 6-15 credits of General Education: 0-9 credits of GN courses; 6 credits of GQ courses, 0-6 credits of GS courses.)

**COMMON REQUIREMENTS FOR THE MAJOR (ALL OPTIONS):** 38-41 credits

**PRESCRIBED COURSES** (37-38 credits)

MATH 140 GQ(4)[1], MATH 141 GQ(4)[1] (Sem: 1-2)

MATH 220 GQ(2-3)[1], MATH 230(4)[1], STAT 184 (1)[1], STAT 200 GQ(4)[1] STAT 380 (3)[1], STAT

414(3)[1], STAT 415(3)[1] (Sem: 3-4)

STAT 461(3)[1], STAT 462(3)[1], STAT 470(3)[1] (Sem: 5-8)

**ADDITIONAL COURSES** (1-3 credits)

STAT 480 (1)[1]; STAT 481 (1)[1]; STAT 482 (1)[1]; STAT 483 (3)[1]

**REQUIREMENTS FOR THE OPTION:** 47-57 credits

**ACTUARIAL STATISTICS OPTION:** 53 credits

*Students who major in statistics with the actuarial statistics option and who wish to complete a concurrent major in mathematics may not choose the actuarial mathematics option in mathematics. Any other option in mathematics is acceptable.*

**PRESCRIBED COURSES** (28 credits)

ECON 102 GS(3), ECON 104 GS(3) (Sem: 1-4)

ACCTG 211(4)[1] (Sem: 3-4)

FIN 301(3)[1], RM 302(3)[1], RM 410(3)[1], RM 411(3)[1], RM 412(3)[1], STAT 463(3)[1] (Sem: 4-8)

**ADDITIONAL COURSES** (12 credits)

Select 3 credits from: CMPSC 101 GQ(3)[1], CMPSC 102(3)[1], CMPSC 121 GQ(3)[1], CMPSC 200 GQ(3)[1],

CMPSC 201 GQ(3)[1], or CMPSC 202 GQ(3)[1] (Sem: 1-4)

Select 9 credits from IE 434(3)[1]; IE 436(3)[1]; MATH 436(3)[1] or MATH 441(3)[1]; MATH 451(3)[1] or

MATH 455(3)[1]; STAT 416(3)[1], STAT 440(3)[1], STAT 464(3)[1], STAT 466(3)[1] (Sem: 5-8)

**SUPPORTING COURSES AND RELATED AREAS** (13 credits)

Select 13 credits from department list (Sem: 1-8)

**APPLIED STATISTICS OPTION:** (47 credits)

**ADDITIONAL COURSES** (15 credits)

Select 3 credits from: CMPSC 101 GQ(3)[1], CMPSC 121 GQ(3)[1], CMPSC 201 GQ(3)[1], or CMPSC 202

GQ(3)[1] (Sem: 1-4)

Select 12 credits from IE 434(3)[1]; IE 436(3)[1], MATH 436(3)[1] or MATH 441(3)[1], MATH 451(3)[1] or

MATH 455(3)[1], STAT 416(3)[1], STAT 440(3)[1], STAT 463(3)[1], STAT 464(3)[1], STAT 466(3)[1] (Sem: 5-8)

**SUPPORTING COURSES AND RELATED AREAS** (32 credits)

Select 32 credits from department list, including a minor in a supporting field other than Mathematics.  
(Sem: 1-8)

(Neither the mathematics major nor the six sigma minor, nor the risk management major with the actuarial

science option may be used to satisfy the minor/concurrent major requirement. If a student wants to work in a supporting field that does not have a minor, he or she can propose a list of six appropriate courses and petition the Statistics Department for approval. It is the student's responsibility to justify the appropriateness of the proposed list. Students must receive a grade of C or better in each of these six courses.)

**BIOSTATISTICS OPTION:** (56-57 credits)

**PRESCRIBED COURSES** (8 credits)

BIOL 110 GN(4)[1], CHEM 110 GN(3)[1], CHEM 111 GN(1)[1] (Sem: 1-3)

**ADDITIONAL COURSES** (28-29 credits)

Select 3 credits from: CMPSC 101 GQ(3)[1], CMPSC 121 GQ(3)[1], CMPSC 201 GQ(3)[1], or CMPSC 202 GQ(3)[1] (Sem: 1-4)

Select 7-8 credits from BIOL 220W GN(4)[1], BIOL 222(3)[1], BIOL 230W GN(4)[1], BIOL 240W GN(4)[1] (Sem: 5-8)

Select 6 credits from 400-level BIOL courses[1] (Sem: 5-8)

Select 12 credits from IE 434(3)[1]; IE 436(3)[1], MATH 436(3)[1] or MATH 441(3)[1], MATH 451(3)[1] or MATH 455(3)[1], STAT 416(3)[1], STAT 440(3)[1], STAT 463(3)[1], STAT 464(3)[1], STAT 466(3)[1] (Sem: 5-8)

**SUPPORTING COURSES AND RELATED AREAS** (19-20 credits)

Select 19-20 credits from department list (Sem: 1-8)

**GRADUATE STUDY OPTION:** (47 credits)

*A student completing the Graduate Study option will have earned a minor in mathematics in addition to a B.S. in Statistics. However, a student must fill out and submit the appropriate paperwork to the Mathematics Department in order for this minor to be officially recognized.*

**PRESCRIBED COURSES** (9 credits)

MATH 312(3)[1], MATH 403(3)[1], MATH 404(3)[1] (Sem: 5-8)

**ADDITIONAL COURSES** (24 credits)

Select 3 credits from: CMPSC 101 GQ(3)[1], CMPSC 121 GQ(3)[1], CMPSC 201 GQ(3)[1], or CMPSC 202 GQ(3)[1] (Sem: 1-4)

Select 9 credits from MATH 310(3)[1], MATH 311W(3-4)[1], MATH 421(3), MATH 422(3)[1], MATH 426(3), MATH 429(3), MATH 456(3)[1], MATH 468(3)[1], MATH 469(3)[1] (Sem: 7-8)

Select 12 credits from IE 434(3)[1]; IE 436(3)[1], MATH 436(3)[1] or MATH 441(3)[1], MATH 451(3)[1] or MATH 455(3)[1], STAT 416(3)[1], STAT 440(3)[1], STAT 463(3)[1], STAT 464(3)[1], STAT 466(3)[1] (Sem: 5-8)

**SUPPORTING COURSES AND RELATED AREAS** (14 credits)

Select 14 credits from department list (Sem: 1-8)

**STATISTICS AND COMPUTING OPTION:** (47 credits)

**PRESCRIBED COURSES** (9 credits)

CMPSC 121 GQ(3)[1], CMPSC 122(3)[1], CMPSC 465(3)[1] (Sem: 1-6)

**ADDITIONAL COURSES** (24 credits)

Select 3 credits from: CMPSC 360(3)[1] or MATH 311W(3-4)[1] (Sem: 3-6)

Select 9 credits from CMPSC 221(3)[1], 400-level CMPSC [1] other than CMPSC/MATH 451 or CMPSC/MATH 455 (Sem: 5-8)

Select 12 credits from IE 434(3)[1]; IE 436(3)[1], MATH 436(3)[1] or MATH 441(3)[1], MATH 451(3)[1] or MATH 455(3)[1], STAT 416(3)[1], STAT 440(3)[1], STAT 463(3)[1], STAT 464(3)[1], STAT 466(3)[1] (Sem: 5-8)

**SUPPORTING COURSES AND RELATED AREAS** (14 credits)

Select 14 credits from department list (Sem: 1-8)

## **Integrated B.S. in Statistics and Master of Applied Statistics (M.A.S.)**

The Integrated Undergraduate-Graduate (IUG) degree with B.S. in Statistics and Master of Applied Statistics (M.A.S.) is designed to be completed in five years. This integrated degree will enable a select number of highly qualified and career-oriented students to obtain training in statistics focused on developing data analysis skills and exploration of core areas of applied statistics at the undergraduate and graduate levels. The M.A.S. degree is a professional master's degree that emphasizes applications and does not provide as much training in the mathematical and statistical theory. The degree prepares students with interests in mathematics, computation, and the quantitative aspects of science for careers in industry and government

as statistical analyst. Research divisions in the pharmaceutical industry, quality control and quality engineering divisions in manufacturing companies, clinical research units, corporate planning and research units, and other data-intensive positions require persons with training in mathematics, computation, database management, and statistical analysis, which this program will provide.

### **Application Process**

The number of openings in the integrated B.S./M.A.S. program is limited. Admission will be based on specific criteria and the recommendation of faculty. Applicants to the integrated program:

1. Must be enrolled in the Statistics B.S. program.
  
1. Must have completed at least 60 credits of the undergraduate degree program including the two courses: STAT 414 and STAT 415, and the students must apply to the program prior to completing 110 credits.
  
1. Must submit a transcript and a statement of purpose.
  
1. Must present a departmental-approved plan of study in the application process in consultation with the M.A.S. program director.
  
1. Must be recommended by the chair of the department's undergraduate program committee.
  
1. Must be accepted into the M.A.S. program in Statistics.

For the IUG B.S./M.A.S. degree, 120 credits are required for the B.S. and 30 credits for the M.A.S. The following twelve graduate-level credits (number of credits in parentheses) can apply to both B.S. and M.A.S. degrees; six of these are at the 500 level:

STAT 414 (3) Introduction to Probability Theory  
STAT 415 (3) Introduction to Mathematical Statistics  
STAT 501 (3) Regression Methods  
STAT 502 (3) Analysis of Variance and Design of Experiments

Assuming all requirements for the B.S. are completed, students in the program can complete the B.S. degree and not advance to the M.A.S. Degree if they desire.

### **Degree Requirements**

IUG Statistics B.S. prescribed Statistics courses: See above, but note that students in IUG Statistics B.S. take STAT 501 and 502 instead of STAT 460 and 462.

IUG Statistics M.A.S. requirement (30 credits)

STAT 414 (3) Introduction to Probability Theory  
STAT 415 (3) Introduction to Mathematical Statistics  
STAT 501 (3) Regression Methods  
STAT 502 (3) Analysis of Variance and Design of Experiments  
STAT 580 (2) Statistical Consulting Practicum I  
STAT 581\*\* (1) Statistical Consulting Practicum II  
Electives (15) Choose from STAT 503-510 and the departmental list of additional courses for the M.A.S. program with the approval of the adviser.

\*\*For all students in the M.A.S. program, the STAT 581 course will have a comprehensive written project report required as part of the course, which serves as the culminating experience.

**[1]** A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

Last Revised by the Department: Fall 2017(STAT); Summer Session 2003 (Integrated B.S./M.A.S.)

Blue Sheet Item #:46-03-063 (STAT); 31-01-123 (Integrated B.S./M.A.S.)

Review Date: 11/14/2017

UCA Revision #1: 9/1/06

UCA Revision #2: 7/30/07

SC

## Associate Degrees

### Minors

## Astronomy and Astrophysics Minor

*University Park, Eberly College of Science (ASTRO)*

The minor in Astronomy and Astrophysics, available at the University Park campus, provides educational options to students with interest in astronomy but with principal commitments to an allied field. It is designed principally for majors in Aerospace Engineering, Electrical Engineering, Engineering Sciences, Geosciences, Meteorology, and Physics. The educational objectives are to provide students with a profound understanding of the large-scale properties and processes in our Universe including planets and solar systems, our Sun and other stars, our Galaxy and other galaxies; and cosmology. Students in the minor survey the field in the 200-level sequence and then select from a choice of advanced astronomy and allied courses. Minors will be encouraged to take advantage of the many undergraduate research opportunities in the department, often using space-based observatories.

A grade of C or better is required for all courses in the minor.

*Scheduling Recommendation by Semester Standing given like (Sem: 1-2)*

**REQUIREMENTS FOR THE MINOR:** 22-23 credits

**PRESCRIBED COURSES** (10 credits)

PHYS 211 GN(4) (Sem: 1-2)

ASTRO 291 GN(3), ASTRO 292 GN(3) (Sem: 3-4)

**ADDITIONAL COURSES** (6-7 credits)

Select 6-7 credits from additional ASTRO 400-level courses, AERSP 308(3), AERSP 312(3), EE 472(3), GEOSC 474(3), METEO 466(3), or PHYS 458(4) (Sem: 5-8)

**SUPPORTING COURSES AND RELATED AREAS** (6 credits)

Select 6 credits from 400-level ASTRO courses, except ASTRO 496 (Sem: 5-8)

Last Revised by the Department: Spring Semester 2015

Blue Sheet Item #: 43-06-000

Review Date: 04/14/2015

UCA Revision #2: 7/26/07

SC

## Biochemistry and Molecular Biology Minor

*University Park, Eberly College of Science (B M B)*

The Biochemistry and Molecular Biology minor provides a foundation in traditional biochemistry and an exploration of the current understanding of molecular biology. The fields of biochemistry and molecular biology are extensively interconnected and are taught in the context of the biology of the cell. Stated another way, the B M B minor is a substantial treatment of life processes at the molecular and cellular levels. The minor requires coursework in general biochemistry, cell biology, and molecular biology. A required laboratory course exposes students to the basic techniques and instrumentation used in modern

biochemistry and molecular biology laboratories. Students considering this minor should be comfortable with the study of chemistry.

A grade of C or better is required for all courses in the minor.

*Scheduling Recommendation by Semester Standing given like (Sem: 1-2)*

**REQUIREMENTS FOR THE MINOR:** 33-35 credits

**PRESCRIBED COURSES:** (29-30 credits)**[11]**

CHEM 110 GN(3), CHEM 112 GN(3) (Sem: 1-2)

BMB 251(3), BMB 252(3), CHEM 210(3), CHEM 212(3) (Sem: 3-4)

BMB 400(2-3), BMB 401(3), BMB 402(3), BMB 442(3) (Sem: 5-6)

**ADDITIONAL COURSES:** (3 credits)

BIOL 222(3) or BIOL 322(3) (Sem: 3-4)

**SUPPORTING COURSES AND RELATED AREAS:** (0-3 credits)**[11]**

Select 0-3 credits of B M B courses at the 400-level (Sem: 7-8)

*Note:* BMB 408(1-2) and BMB 496(1-18) may not be used to fulfill requirements for the minor.

Last Revised by the Department: Spring Semester 2015

Blue Sheet Item #: 43-06-000

Review Date: 04/14/2015

SC

## Biology Minor (BIOL)

*Contacts: Altoona College, Edward Levri, [epi1@psu.edu](mailto:epi1@psu.edu); Eberly College of Science, Barbara DeHart, [bzd2@psu.edu](mailto:bzd2@psu.edu); Penn State Abington, Eric Ingersoll, [epi1@psu.edu](mailto:epi1@psu.edu); Penn State Berks, Maureen Dunbar, [med18@psu.edu](mailto:med18@psu.edu); Penn State York, Dr. Anne Vardo-Zalik, [amy12@psu.edu](mailto:amy12@psu.edu)*

This minor is designed for students in non-Life Science majors, who desire to obtain an in-depth and well-rounded knowledge of Biology -- the science of life and living organisms. This minor is not intended for "Life Science" oriented majors, including Biological Anthropology, Premedicine, and Science, Life Science option. After taking an introductory survey course which exposes students to the basics of Biology, including the chemistry of life, cell structure, genetics, mechanisms of evolution and evolutionary history of biological diversity, plant and animal form and function, and ecology, students select additional courses based on their biological emphasis to account for a total of 18-20 credits. In conjunction with the student's major, the minor prepares students for entry to graduate school or professional school programs, as well as for technical or research careers with governmental agencies or industry. Majors complemented by this minor would include but not be limited to other life and physical sciences, engineering, and business.

A grade of C or better is required for all courses in the minor.

*Scheduling Recommendation by Semester Standing given like (Sem: 1-2)*

**REQUIREMENTS FOR THE MINOR:** 18-20 credits

**PRESCRIBED COURSES** (4 credits)

BIOL 110 GN(4) (Sem. 5-6)

**ADDITIONAL COURSES** (7-8 credits)

Select 7-8 credits from BIOL 129 GN(4), BIOL 141 GN(3), BIOL 142(1), BIOL 222(3), BIOL 220W GN(4), BIOL 230W GN(4), BIOL 240W GN(4), BIOL 322(3) (Sem: 5-8)

**SUPPORTING COURSES AND RELATED AREAS** (6-9 credits)

Select 6-9 credits from 400-level Biology courses (BIOL 400, BIOL 496, and SC 495 credits may not be used to fulfill this requirement.) (Sem: 5-8)

Last Revised by the Department: Fall Semester 2007

Blue Sheet Item #: 35-06-521

Review Date: 4/10/07

## Chemistry Minor

*Penn State Berks, Ivan Shibley, [ias1@psu.edu](mailto:ias1@psu.edu)  
University Park, Eberly College of Science (CHEM)*

*Contact: Altoona College - Richard Bell, [rcb155@psu.edu](mailto:rcb155@psu.edu); Penn State Erie, The Behrend College - Grace Galinato, [mig11@psu.edu](mailto:mig11@psu.edu); Eberly College of Science - Mark Maroncelli, [mxm11@psu.edu](mailto:mxm11@psu.edu)*

The minor in Chemistry complements degrees in other areas of physical and biological science and introduces students to fundamental principles of chemistry through lecture and laboratory course work.

A grade of C or better is required for all courses in the minor.

*Scheduling Recommendation by Semester Standing given like (Sem: 1-2)*

**REQUIREMENTS FOR THE MINOR:** 26-28 credits

**PRESCRIBED COURSES:** (16 credits)

CHEM 110 GN(3), CHEM 111 GN(1), CHEM 112 GN(3), CHEM 113 GN(1), CHEM 210(3), CHEM 212(3), CHEM 213(2) (Sem: 1-4)

**ADDITIONAL COURSES:** (10-12 credits)

Select 4 credits from CHEM 221(4) or 6 credits from CHEM 450(3) or CHEM 466(3) and CHEM 452(3)(Sem: 3-8)

Select 6 credits from 400-level CHEM not used above and excluding CHEM 494(1-10), CHEM 494H(1-10), CHEM 495(1-18), and CHEM 496(1-18) (Sem: 5-8)

Last Revised by the Department: Fall Semester 2014

Blue Sheet Item #: 43-04-102

Review Date: 01/13/2015

UCA Revision #1: 9/20/06

SC

## Information Sciences and Technology for Mathematics Minor

*University Park, Eberly College of Science (ISMTH)*

The interaction between Information Sciences and Mathematics will continue developing in remarkable new directions. Mathematical scientists enormously benefit from information technology in the performance of research, in communicating and disseminating scientific information and results, as well as in career environments involving data analysis and management. Mathematicians also contribute to making inroads toward the development of new information technologies. Information sciences and technology are already playing a very important role in mathematical education, at all levels, and will experience an overwhelming increase in the near future. Giving undergraduate mathematics students the opportunity to minor in IST will not only enrich their educational achievements but it will also help them succeed in the employment searches.

Students must apply for entrance to the minor no later than the beginning of their senior year.

A grade of C or better is required in all courses in the minor.

*Scheduling Recommendation by Semester Standing given like (Sem: 1-2)*

**REQUIREMENTS FOR THE MINOR:** 18 credits

**PRESCRIBED COURSES** (9 credits)

IST 110 GS(3) (Sem: 1-2)

IST 210(3) Sem: 3-4)

IST 220(3) (Sem: 5-6)

**ADDITIONAL COURSES** (9 credits)

Select 9 credits from the following 400-level mathematics courses: MATH 451(3), MATH 457(3), MATH 459(3), MATH 465(3), MATH 467(3), MATH 468(3), MATH 469(3) (Sem: 5-8)

Last Revised by the Department: Fall Semester 2014

Blue Sheet Item #: 43-03-091

Review Date: 11/18/2014

SC

PIC updated by Publications: 3/26/09

## Mathematics Minor (MATH)

Contact: Altoona College, Dan DiLeo, [dxd22@psu.edu](mailto:dxd22@psu.edu); Eberly College of Science, James Sellers, [jxs23@psu.edu](mailto:jxs23@psu.edu)

The minor is designed to provide students with an interest in mathematics an opportunity to study a broad range of mathematical topics. The requirements allow students a great deal of flexibility in choosing courses of interest.

A grade of C or better is required for all courses in the minor.

*Scheduling recommendation by Semester Standing given like (Sem: 1-2)*

**REQUIREMENTS FOR THE MINOR:** 26-28 credits

**PRESCRIBED COURSES** (8 credits)

MATH 140 GQ(4), MATH 141 GQ(4) (Sem: 1-4)

**ADDITIONAL COURSES** (6-8 credits)

Select 6-8 credits from MATH 220 GQ(2-3), MATH 230(4), MATH 231(2), MATH 232(2), MATH 250(3), MATH 251(4), MATH 310(3), MATH 311W(3-4), or MATH 312(3) (Sem: 1-4)

**SUPPORTING COURSES AND RELATED AREAS** (12 credits)

Select 12 credits of 400-level MATH courses (Sem: 5-8)

Last Revised by the Department: Fall Semester 2001

Review Date: 5/10/04

UCA Revision #1: 8/9/06

## Microbiology Minor

*University Park, Eberly College of Science (MICRB)*

The minor in Microbiology is a collection of required and elective courses that (1) provides a limited but sound foundation in the discipline, (2) requires students to develop reasonable expertise in handling and characterizing microorganisms, and (3) permits students to emphasize some subdiscipline of microbiology in which they may have a particular interest. The minor specifies the introductory lecture and laboratory courses in microbiology and one course each in immunology and cell biology. A minimum of two laboratory courses exposes students to basic and experimental/applied techniques. Sufficient room exists within the minor for selection of two or three elective courses at the advanced level that may emphasize a specialty area of the discipline such as virology or microbial genetics. Students who complete the minor have a sufficient background to pursue positions in industry that require an appreciable expertise in microbiology.

A grade of C or better is required for all courses in the minor.

*Scheduling Recommendation by Semester Standing given like (Sem: 1-2)*

**REQUIREMENTS FOR THE MINOR:** 24 credits

**PRESCRIBED COURSES** (17 credits)

CHEM 110 GN(3), CHEM 112 GN(3), MICRB 201(3), MICRB 202(2), MICRB 251(3) (Sem: 3-4)  
MICRB 410(3) (Sem: 5-6)

**ADDITIONAL COURSES** (2-3 credits)



Select 2-3 credits from MICRB 421(3) or MICRB 422(2) (Sem: 5-6)

**SUPPORTING COURSES AND RELATED AREAS** (4-5 credits)

Select 4-5 credits of 400-level MICRB courses (Sem: 5-8)

*Note:* BMB 442(3), MICRB 408(1-2), MICRB 496(1-18) and MICRB 497(1-9) may not be used to fulfill the requirements for the minor.

Last Revised by the Department: Spring Semester 2015

Blue Sheet Item #: 43-06-000

Review Date: 04/14/2015

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## Natural Science Minor (NATSC)

*Contacts:* Altoona College, David Hurtubise, [dxh40@psu.edu](mailto:dxh40@psu.edu); Berks College, Ike Shibley, [ias1@psu.edu](mailto:ias1@psu.edu); Eberly College of Science, Ron Markle, [ram29@psu.edu](mailto:ram29@psu.edu)

This interdepartmental minor in Natural Science is designed for nonscience students who wish to gain a better appreciation for science and the scientific method. The courses required in the minor include 3 to 4 credits of general education science designed for nonscience students, 3 to 4 credits of mathematical science, 8 to 9 credits of life or physical science, including some laboratory work, and 6 credits of 400-level science courses. Certain combinations of courses are disallowed (as listed in the curriculum description), and higher-level courses are generally accepted as substitutes for lower-level courses if both are offered by the same department. Any substitutes for laboratory courses must also be laboratory courses. Advising for students in this minor will be available through the Eberly College of Science Academic Advising Center and approval of curriculum exceptions will be through the faculty committee and professor in charge of the program.

A grade of C or better is required for all courses in the minor.

*Scheduling Recommendation by Semester Standing given like (Sem: 1-2)*

**REQUIREMENTS FOR THE MINOR:** 20-23 credits

**PRESCRIBED COURSE** (1 credit)

SC 400(1) (Sem: 5-8)

**ADDITIONAL COURSES** (14-17 credits)**[62]**

Select 3-4 credits from ASTRO 1 GN(3), ASTRO 10 GN(2) and ASTRO 11 GN(1), BMB 1 GN(3), BISC 1 GN(3), BISC 2 GN(3), BISC 3 GN(3), BISC 4 GN(4), CHEM 1 GN(3), CHEM 3 GN(3), MICRB 106 GN(3) and MICRB 107 GN(1), PHYS 1 GN(3) (Sem: 1-4)

Select 3-4 credits from CMPSC 101 GQ(3), CMPSC 121 GQ(3), CMPSC 201 GQ(3) or CMPSC 202 GQ(3), CMPSC 203 GQ(4), MATH 110 GQ(4), MATH 140 GQ(4), STAT 200 GQ(4), STAT 250 GQ(3) (Sem: 3-6)

Select 8-9 credits from BIOL 11 GN(3) and BIOL 12 GN(1), BIOL 110 GN(4), CHEM 110 GN(3) and CHEM 111 GN(1), CHEM 112 GN(3) and CHEM 113 GN(1), MICRB 201(3) and MICRB 202(2), PHYS 250 GN(4), PHYS 251 GN(4) (Sem: 3-8)

**SUPPORTING COURSES AND RELATED AREAS** (5 credits)

Select 0-2 credits of 496 (independent studies) courses from the Eberly College of Science course offerings (Sem: 5-8)

Select 3-5 credits of 400-level courses (other than independent studies) from the Eberly College of Science course offerings (Sem: 5-8)

**[62]** A student may not use credit for BISC 1 GN(3) or BISC 2 GN(3) along with credit for BIOL 11 GN(3) and BIOL 12 GN(1), or BIOL 110 GN(4); CHEM 1 GN(3) or CHEM 3 GN(3) along with credit for CHEM 110 GN(3) and CHEM 111 GN(1) or CHEM 112 GN(3) and CHEM 113 GN(1); PHYS 1 GN(3) along with credit for PHYS 250 GN(4) or PHYS 251 GN(4); MICRB 106 GN(3) and MICRB 107 GN(1) along with credit for MICRB 201(3) and MICRB 202(2).

Last Revised by the Department: Summer Session 1995

Blue Sheet Item #: 23-04-042

Review Date: 9/13/02

UCA Revision #1: 8/9/06  
UCA Revision #2: 7/30/07

## Physics Minor

Eberly College of Science (PHYS)

Contact: Eberly College of Science, Richard Robinett, [rq9@psu.edu](mailto:rq9@psu.edu)

Contact: Behrend College, Bruce Wittmershaus, [bpw2@psu.edu](mailto:bpw2@psu.edu)

Contact: Penn State Berks, Leonard Gamberg, [lpg10@psu.edu](mailto:lpg10@psu.edu)

The Department of Physics offers a minor for students who wish to expand upon their study in this fundamental discipline, beyond the introductory courses (PHYS 211, PHYS 212, PHYS 213, PHYS 214). In addition to an additional course in modern physics (PHYS 237, which includes introductions to relativity and quantum theory, as well as applications), students take two 400-level PHYS courses for a total of 6-8 credits. The Physics minor is useful for students in many STEM disciplines who wish to extend their studies in this fundamental field, as a background for graduate study or work in a variety of technical fields.

A grade of C or better is required for all courses in the minor.

*Scheduling Recommendation by Semester Standing given like (Sem: 1-2)*

**REQUIREMENTS FOR THE MINOR:** 29-31 credits

**PRESCRIBED COURSES** (23 credits)

MATH 140 GQ(4), MATH 141 GQ(4), PHYS 211 GN(4), PHYS 212 GN(4), PHYS 213 GN(2), PHYS 214 GN(2), PHYS 237(3) (Sem: 1-4)

**SUPPORTING COURSES AND RELATED AREAS** (6-8 credits)

Select two 400-level PHYS courses, except PHYS 444(2), 445(1), 446(1), 457(1-3), 457W(3), 494(1), 494H(1), 495(1), 496(1), 496H(1) or 499(1) (Sem: 5-8)

Last Revised by the Department: Spring Semester 2016

Blue Sheet Item #: 44-04-081

Review Date: 1/12/16

UCA Revision #1: 8/31/06

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## Planetary Science and Astronomy Minor

*University Park, Eberly College of Science (PASTR)*

Planetary Science and Astronomy minors will study the Solar System, stars, galaxies and the universe as a whole. Students will survey a wide variety of topics in astronomy and will learn to solve problems to see how this general knowledge has been obtained. Students will use telescopes to obtain astronomical data, and will learn to analyze these data to constrain astronomical theories. Communication of these topics, both oral and written, to the public and to their peers will be emphasized, as will logic and general problem-solving skills. It will serve students who want to acquire a significant knowledge of the universe as they pursue majors in unrelated fields of study. For example, this minor will serve students who are seeking careers in science education at the 6-12 level, in elementary education, in science journalism, and in geoscience.

A grade of C or better is required for all courses in the minor.

**REQUIREMENTS FOR THE MINOR:** 19 credits

**PRESCRIBED COURSES** (7 credits)

ASTRO 401(4), ASTRO 402(3) (Sem: 5-8)

**ADDITIONAL COURSES** (12 credits)

Select 3 credits from ASTRO 1 GN(3), ASTRO 5 GN(3), ASTRO 6 GN(3), ASTRO 10 GN(2) and ASTRO 11GN(1), ASTRO 291 GN(3) (Sem: 1-4)

Select 9 credits from ASTRO 120 GN(3), ASTRO 130 GN(3), ASTRO 140 GN(3), ASTRO 292 GN(3) (Sem: 2-6)

Last Revised by the Department: Spring Semester 2013

Blue Sheet Item #: 41-05-145

Review Date: 02/19/2013

## Statistics Minor

*University Park, Eberly College of Science (STAT)*

Contact: David Hunter, [drh20@psu.edu](mailto:drh20@psu.edu), Department Head Statistics

The Statistics minor introduces students to the quantitative aspects of research. Understanding statistics is useful for research in many areas including agriculture, business, education, social science and sciences as well as many jobs in industry and government.

Some course may require other course work as some courses have prerequisites.

A grade of C or better is required for all courses in the minor.

*Scheduling Recommendation by Semester Standing given like (Sem: 1-2)*

**REQUIREMENTS FOR THE MINOR:** 24 -26 credits

**PRESCRIBED COURSES** (8 credits)

MATH 140 GQ(4), MATH 141 GQ(4) (Sem: 1-2)

**ADDITIONAL COURSES** (16-18 credits)

Select 6 credits from STAT 301(3); STAT 318(3); STAT 319(3); STAT 401(3); STAT 414(3); STAT 415(3) (Sem: 3-8)

Select 10-12 credits from 400-level STAT courses, not including STAT 401, STAT 414, STAT 415, or STAT 418. (Sem: 5-8)

Last Revised by the Department: Fall Semester 2016

Blue Sheet Item #: 45-01-137

Review Date: 8/23/2016

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