<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table of Contents</td>
<td>2</td>
</tr>
<tr>
<td>Department Statistics</td>
<td>3</td>
</tr>
<tr>
<td>Faculty Research Areas</td>
<td>4 - 6</td>
</tr>
<tr>
<td>Instruction Faculty</td>
<td>7 - 9</td>
</tr>
<tr>
<td>How Do I</td>
<td>10 - 11</td>
</tr>
<tr>
<td>Introduction</td>
<td>12</td>
</tr>
<tr>
<td>Entrance to Eberly College of Science</td>
<td>12</td>
</tr>
<tr>
<td>Entrance to Major</td>
<td>12</td>
</tr>
<tr>
<td>Special Options within Major</td>
<td>13</td>
</tr>
<tr>
<td>Supporting Courses</td>
<td>13</td>
</tr>
<tr>
<td>General Education</td>
<td>13</td>
</tr>
<tr>
<td>United States &amp; International Cultures Requirement</td>
<td>13</td>
</tr>
<tr>
<td>Foreign/Second Language Admission Requirement</td>
<td>13</td>
</tr>
<tr>
<td>Concurrent Major</td>
<td>13</td>
</tr>
<tr>
<td>Supporting Courses</td>
<td>13</td>
</tr>
<tr>
<td>General Education</td>
<td>13</td>
</tr>
<tr>
<td>United States &amp; International Cultures Requirement</td>
<td>13</td>
</tr>
<tr>
<td>Foreign/Second Language Admission Requirement</td>
<td>13</td>
</tr>
<tr>
<td>Concurrent Major</td>
<td>13</td>
</tr>
<tr>
<td>Honors Courses and the University Scholars Program</td>
<td>14</td>
</tr>
<tr>
<td>Minor in Biochemistry &amp; Molecular Biology</td>
<td>14</td>
</tr>
<tr>
<td>Minor in Microbiology</td>
<td>14</td>
</tr>
<tr>
<td>Evaluation of Courses from Other Universities</td>
<td>15</td>
</tr>
<tr>
<td>Degree Audit</td>
<td>15</td>
</tr>
<tr>
<td>Career-Related Experience and Study Abroad Opportunities</td>
<td>15 - 16</td>
</tr>
<tr>
<td>Science Job Shadowing/Externship Program (First-Year, Sophomore Year)</td>
<td>15</td>
</tr>
<tr>
<td>Science Cooperative Education (Junior/Senior Years)</td>
<td>15</td>
</tr>
<tr>
<td>Science Internship</td>
<td>16</td>
</tr>
<tr>
<td>International Opportunities</td>
<td>16</td>
</tr>
<tr>
<td>Career Related Resources</td>
<td>16</td>
</tr>
<tr>
<td>Biochemistry &amp; Molecular Biology w/Biochemistry Option</td>
<td>17 - 22</td>
</tr>
<tr>
<td>Biochemistry &amp; Molecular Biology w/Molecular &amp; Cell Biology Option</td>
<td>23 - 28</td>
</tr>
<tr>
<td>Biotechnology w/General Option</td>
<td>29 - 34</td>
</tr>
<tr>
<td>Biotechnology w/Clinical Laboratory Science Option</td>
<td>35 - 40</td>
</tr>
<tr>
<td>Microbiology</td>
<td>41 - 46</td>
</tr>
<tr>
<td>Student Based Organizations</td>
<td>47</td>
</tr>
<tr>
<td>Research/Scholarships</td>
<td>48</td>
</tr>
<tr>
<td>University Learning Centers</td>
<td>49</td>
</tr>
<tr>
<td>Office of Disability Services</td>
<td>49</td>
</tr>
<tr>
<td>Climate &amp; Diversity</td>
<td>50</td>
</tr>
</tbody>
</table>
The administrative office for the academic programs in Biochemistry & Molecular Biology, Biotechnology and Microbiology is located on the first floor of Althouse Laboratory. Faculty offices are located in six nearby buildings: Althouse Lab, Chemistry Building, North & South Frear, Wartik Lab, Life Science Building, Millennium Science Complex.

Department Statistics

Current Faculty .................................................................69

Fall 2012 Department Enrolled Undergraduate Students ........523
Fall 2012 Undergraduate Students (graduated)
  Biochemistry & Molecular Biology..................................19
  Biotechnology.............................................................04
  Microbiology............................................................04

Spring 2013 Department Enrolled Undergraduate Students....447
Spring 2013 Undergraduate Students (graduated)
  Biochemistry & Molecular Biology...............................68
  Biotechnology..........................................................25
  Microbiology...........................................................13

V. Reddy Padala, senior lecturer I of biochemistry & molecular biology, and student marshal Chetan Safi
Faculty Research Areas

Sarah Ades - Signal transduction and antibiotic induced stress responses in bacteria
Istvan Albert - Developing & integrating computational tools into life sciences research
Paul Babitzke - Regulation of gene expression by RNA structure and RNA-binding proteins
Lu Bai - Single cell/single molecule study of chromatin and gene regulation
J. Martin Bollinger* - Mechanisms of metalloenzymes and metallofactor assembly
Squire Booker* - Mechanisms of cofactor action in enzymatic reactions
Donald Bryant - Physiology, biochemistry, genetics, and genomics of photosynthetic bacteria
Craig Cameron - RNA polymerases and RNA-binding proteins in viral infection and mitochondrial disease
Frank Dorman - Fundamental studies into chromatographic separations and applied chromatographic separation of trace compounds in complex matrices
J. Gregory Ferry - Enzymology and functional genomics
Richard Frisque - Molecular approaches to the unique biology of JC virus
David Gilmour - Transcriptional regulation of the hsp70 heat shock gene in Drosophila
Santhosh Girirajan - Genetics of neurodevelopmental disorders
John H. Golbeck - Structure-function relationships with photosynthetic reaction centers
Ying Gu - Mechanism of cellulose biosynthesis in arabidopsis
Wendy Hanna-Rose - Molecular genetics of metabolism and development in C. elegans
Ross C. Hardison - Genomics and gene regulation
Mitchell Holland - Forensic science
Teh-hui Kao - Biochemical and molecular bases of self/non-self recognition during plant reproduction
Kenneth Keiler - Small RNAs and protein localization in bacterial development and antimicrobial drug discovery
Andrey Krasilnikov - Structural biology of RNA and RNA-protein complexes
Maria Krasilnikova - Mechanisms of trinucleotide repeats diseases
Carsten Krebs* - Bioinorganic chemistry-spectroscopic and kinetic studies on the mechanisms of iron-containing enzymes
Zhi-Chun Lai* - Growth control and cancer genetics
Arthur Lesk - Protein structure, function and evolution
Scott E. Lindner - Molecular parasitology and structural biology of malaria (*Plasmodium* spp.)

Manuel Llinás - Understanding the mechanisms of gene regulation in *plasmodium*

Bernhard Lüscher* - Structure, function and post-synaptic targeting of GABAA receptors

Shaun Mahony - Computational biology and regulatory genomics

Andrea Mastro - Breast cancer and immune system

Paul Medvedev* - Computational genomics

Tim Miyashiro - Bacterial gene expression within natural host environments; host microbe symbioses

Katsuhiko Murakami - Structural and mechanistic enzymology of prokaryotic RNA polymerases

Anton Nekrutenko - Comparative genome analysis

B. Tracy Nixon - Signal transduction in procaryotes: functional domains of rhizobium dct gene

Kathleen Postle - Signal transduction and iron transport in bacteria

Frank Pugh - Biochemistry and genomics eukaryotic transcription regulation

Joseph Reese - Chromatin structure and gene expression, DNA damage resistance pathways

Marylyn Ritchie - Bioinformatics, computational genomics, pharmacogenomics, genetic architecture of complex human traits

Melissa Rolls - Subcellular compartmentalization of neurons

Lorraine Santy - Small GTPase regulation of epithelial cell motility

Stephan Schuster - Genome evolution in host-adapted bacteria

Scott B. Selleck - Regulation of growth factor signaling, proteoglycan modulation of morphogen function, nervous system assembly and synapse development

Moriah L. Szpara - Neurovirology, genomics of pathogen variation, neuron-virus relationships

Song Tan - Structural biology of eukaryotic gene regulation

Graham Thomas* - Roles of the cytoskeleton in *drosophila* development: molecular and genetic approaches

Ming Tien - Characterization and biochemical analysis of cellulose synthesis in a variety of organisms. Mechanism and regulation of fungal degradation of lignin. Dissimilatory iron reduction

Yanming Wang - Epigenetic histone modifications in cell differentiation and cancer
Thomas K Wood* - Discovering the genetic basis of biofilm formation with E. coli and P. aeruginosa. Discerning the role of toxin/antitoxin systems and cryptic prophages. Evolving biofilm regulators to control biofilm formation for biorefineries. Evolving bidirectional hydrogenases for hydrogen production. Understanding interkingdom cell communication

Members of the BMMB Graduate Program from Other Departments

Eric Harvill - Bacterial virulence factors, host immune functions, and molecular cross-talk between pathogen and host

Gary Perdew - Molecular mechanism(s) of toxicity; dioxin mediated signal transduction; biochemistry of heat shock protein complexes

Robert Paulson - Genetic and biochemical analysis of hematopoiesis

Jeffrey M. Peters - Peroxisome proliferator-activated receptors

* faculty with joint appointments in the Department of Biochemistry and Molecular Biology
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<tr>
<th>Name</th>
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<tr>
<td>ANJULI DATTA</td>
<td>Academic Program Adviser</td>
<td><a href="mailto:aud17@psu.edu">aud17@psu.edu</a></td>
<td>PSU 016, BI SC 001, 002, BMB 001, 211</td>
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<tr>
<td></td>
<td>Instructor, Biochemistry &amp; Molecular Biology</td>
<td></td>
<td>MICRB 107</td>
</tr>
<tr>
<td>MEREDITH DEFELICE</td>
<td>Lecturer of Biochemistry &amp; Molecular Biology</td>
<td><a href="mailto:mrd22@psu.edu">mrd22@psu.edu</a></td>
<td>BMB/MICRB 442, BMB 221, 401, 445W</td>
</tr>
<tr>
<td>REBECCA FALSONE</td>
<td>Biotechnology CLS Program Adviser</td>
<td><a href="mailto:raf15@psu.edu">raf15@psu.edu</a></td>
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<tr>
<td></td>
<td>Prep-Room Supervisor</td>
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<tr>
<td>HEATHER GIEBINK</td>
<td>Graduate Student Administrator</td>
<td><a href="mailto:hug14@psu.edu">hug14@psu.edu</a></td>
<td>BI SC 002</td>
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<tr>
<td></td>
<td>Lecturer, Biochemistry &amp; Molecular Biology</td>
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<tr>
<td>JAMES ENDRES HOWELL</td>
<td>Director of Undergraduate Studies</td>
<td><a href="mailto:howell@psu.edu">howell@psu.edu</a></td>
<td>BMB 398A, PSU 016, B M B 251</td>
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<td>B.S., Microbiology, Texas A&amp;M University</td>
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<td>M.S., Biomedical Sciences, University of North Texas Health Sciences Center</td>
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<td>B.S., Biochemistry, Occidental College</td>
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<td>Ph.D., Cell Biology, Duke University</td>
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<td></td>
<td>B.S., Biochemistry, Union College in Schenectady NY</td>
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<td>Ph.D., Biological Chemistry, University of Michigan</td>
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<tr>
<td></td>
<td>B.S., Molecular Biology, University of Pittsburgh</td>
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<td></td>
<td>Ph.D., Molecular and Cell Biology, University of California, Berkeley</td>
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</table>
Instructional Faculty

**STEVEN KEATING**
119 South Frear
email: swk6@psu.edu
Senior Lecturer II, Biochemistry & Molecular Biology
B.S., Microbiology, University of Maryland
Ph.D., Entomology, The Pennsylvania State University
Courses taught: BI SC 002, 004, MICRB 106, 107, 201, 202

**V. REDDY PADALA**
167 North Frear
email: vrp2@psu.edu
Senior Lecturer I, Biochemistry & Molecular Biology
B.S., Agricultural Science, Agricultural College, Bapatla (AP) India
M.S., Biochemistry, GB Pant University, Pantnagar (UP) India
Ph.D., Biochemistry, Indian Institute of Science, Bangalore, India
Courses taught: BMB 212, 408, 443W, 437, BMB/MICRB 442

**CARL SILLMAN**
123 South Frear
email: ces3@psu.edu
Senior Lecturer II, Biochemistry & Molecular Biology
B.S., Biology, Muhlenberg College
M.S., Microbiology, The Pennsylvania State University
Ph.D., Microbiology, The Pennsylvania State University
Courses taught: BMB 446, 498B, MICRB 106, 408, 421W, 422, 447, BIOTC/MICRB 416

**BEATRICE SIRAKAYA**
201 North Frear
email: bxs205@psu.edu
Instructor, Biochemistry & Molecular Biology
B.S., Microbiology, The Pennsylvania State University
Ph.D., Biotechnology, The Pennsylvania State University
Courses taught: BI SC 002, BIOTC/HORT 459, BIOTC 479 & 489.

**OLA SODEINDE**
120 South Frear
email: oas1@psu.edu
Senior Lecturer II, Biochemistry & Molecular Biology
B.S., Anatomy & Experimental Pathology, University of St. Andrews, Scotland
Ph.D., Molecular Genetics & Microbiology, University of Massachusetts Medical School
Courses taught: PSU 016, MICRB 201, BMB 251H, 252, 252H, BIOTC/HORT 459
MICHAEL TROYAN
116E South Frear Lab
email: mbt102@psu.edu
Instructor, Biochemistry & Molecular Biology
B.S., Microbiology, The Pennsylvania State University
M.S., Physiology, The Pennsylvania State University
Courses taught: PSU 016, MICRB 106, MICRB 107, BI SC 004, BIOTC/VB SC 489

HEMANT YENNAWAR
8A Althouse Laboratory
Phone: 814-865-8383
email: hpy1@psu.edu
Instructor of Biochemistry & Molecular Biology
B.S., Physics, Chemistry & Mathematics, Nagpur University, India
M.S., Physics, Nagpur University, India
Ph.D., Physics (X-ray Crystallography), India Institute of Science, Bangalore
Courses taught: BMMB 598E
How does the advising system in the BMB Department work?
The advising system in the BMB, BIOTC, and MICRB majors is multi-tiered and thus provides back-up capacity. All students are assigned two advisers for the first two years of their undergraduate experience.

The academic adviser provides assistance with the scheduling of courses, explanations of University and department policies and procedures, and with the selection of forms required to implement various actions.

At the beginning of the junior year, the academic adviser transfers all advising responsibilities to the professional adviser who is assigned for the entire undergraduate experience. So, while serving as a back-up to the academic adviser in the first two years of academic study, the professional adviser assumes full responsibility for advising during the junior and senior years at a time when choosing electives, selecting graduate or professional schools, and investigating career opportunities begins to take center stage in the advising process.

Backing up both the academic and professional advisers is the Director of Undergraduate Studies, Dr. James Endres Howell and BMB’s Program Adviser, Anjuli Datta. Students also have access to full-time advisers in the Eberly College of Science Academic Advising Center.

How do I meet with my assigned adviser?
Your adviser’s name is available in eLion. Check your adviser’s office door for posted office hours. Knock on the door, email, and/or call. Most faculty prefer that you make an appointment.

What is the Advising Center in the Eberly College of Science?
Each department/major within the college has its own advising resources. One of the Academic Advising Center’s functions is to assist you in navigating and utilizing advising services offered within the college. We are happy to provide referrals to appropriate personnel to answer your advising related questions.

Where is the Advising Center located?
The center is located in the East Wing of the Ritenour Building, can be reached by phone at 814-863-3889, and is open Monday to Friday from 8:00 a.m. to 5:00 p.m. except on University holidays.

Have a question? Need a referral to academic advising services? Ask the Science Adviser!

How do I schedule an appointment with the BMB Department Advisers located in the Advising Center?
You can schedule an appointment by going to Schedule an Appointment on the BMB website. (bmb.psu.edu/appointment)
How Do I . . .

**Determine which courses will fulfill my degree requirements?**
To check on your degree requirements and progress, access your degree audit in eLion: [https://elion.psu.edu/](https://elion.psu.edu/). Pluses (+) and minuses (-) indicate whether degree requirements have been met. To graduate, all categories must display a (+) sign.

**Add or drop a class?**
There are three periods related to adding/dropping a course they are as follows:

**Pre-semester period**: begins on the first day of scheduling and ends the day before the semester starts. Click [http://www.registrar.psu.edu/Reg_Timetable/RegTimetable_Main.cfm](http://www.registrar.psu.edu/Reg_Timetable/RegTimetable_Main.cfm) to see your registration date.

**Add/drop period**: begins the day your courses start, and ends 10% of the way through a course. You can find the semester dates by checking the academic calendar posted on the University Registrar’s website. If you are looking to drop a course, be sure to find out the “last day of regular drop” for your course via eLion. Once you are logged in click on “Course Drop Dates”.

**Late drop period**: starts the day after the add/drop period finishes and ends approximately 80% of the way through a course. You can also find the late drop dates on eLion – click on “Course Drop Dates. Additionally, during the late drop period, the University assesses a $6 per course processing fee for any course dropped or added. During the pre-semester period, you can add and drop courses as many times as needed to create a suitable schedule without financial implications.

**Get into a class that is full?**
Students cannot be added to classes that are filled to room capacity. If enrollment does not exceed the room capacity, you may try to obtain the instructor’s permission to enroll in the class, using an Add/Drop form. If the instructor signs the form, take it to the department that offers the course to schedule the class.

**Get a grade changed?**
If you disagree with a grade you have received for a course, speak with the instructor. Take whatever supporting material you may have to support the change of grade with you. Only course instructors are authorized to assign and change grades.

**Get access to the computer lab?**
122 South Frear computer lab is open from 9:00 a.m. - 4:00 p.m.

**Change my major?**
To change your major to BMB, BIOTC or MICRB you must meet with the Director of Undergraduate Studies, Dr. James Endres Howell or Academic Program Adviser, Anjuli Datta. You can schedule an appointment by going to bmb.psu.edu/schedule-appointment. The advisers have the appropriate paper work for you to complete.

**Schedule a World Campus course?**
Visit Penn State Online at: [http://www.worldcampus.psu.edu/](http://www.worldcampus.psu.edu/) for an application and course selections.

**Get involved with a student organization?**
Go to general meetings and express an interest. General meetings are usually held at the beginning of the fall semester to recruit new members. Most groups publicize these meetings by posting notices university-wide. Penn State chapters of the Biochemistry Society and the American Society for Microbiology post notices on the bulletin boards in Althouse and South Frear and also broadcast via email.
Introduction

Welcome to the Department of Biochemistry and Molecular Biology. The Department of Biochemistry and Molecular Biology offers undergraduate students a choice of majors in three of the most exciting areas of the life sciences:

- **Biochemistry and Molecular Biology (BMB)**
  - Biochemistry Option
  - Molecular & Cell Biology Option
- **Microbiology (MICRB)**
- **Biotechnology (BIOTC)**
  - General Option
  - Clinical Laboratory Science Option

In this handbook, we give an overview of the various options available within the biochemistry and molecular biology department and their course requirements. When planning your program of studies, use the check sheets in this program guide together with information available online (online advising service at [https://elion.psu.edu](https://elion.psu.edu), undergraduate degree bulletin at [http://www.psu.edu/bulletins/bluebook](http://www.psu.edu/bulletins/bluebook)), and consult your assigned adviser. For more information about anything pertaining to the undergraduate programs in BMB please consult your assigned adviser (if you are currently a BMB/MICRB or BIOTC major) or the Director of Undergraduate Studies, Dr. James Endres Howell or BMB’s Academic Program Adviser, Anjuli Datta.

Department Contacts:

Dr. James Endres Howell  
Director Undergraduate Studies  
220 South Frear  
Phone: 814-865-7736 or email jhowell@psu.edu

Dr. Wendy Hanna-Rose  
Associate Department Head for Undergraduate Studies  
104D Life Science Building or email  
Phone: 814-865-7904 or email wxh21@psu.edu

Anjuli Datta  
Program Adviser  
124 South Frear  
Phone: 814-865-4825 or email aud17@psu.edu

Lorraine Grattan  
Coordinator Student Studies  
107B Althouse  
Phone: 814-863-4925 or email lorraine@psu.edu

Admission and Retention

Entrance to the Eberly College of Science

Any student entering the college may seek entrance to any major in the college if the following requirements have been met:

1. The student must have a 2.00 cumulative grade point average.
2. The student must have completed Math 140 with a C or better.

Entrance to the BMB, MICRB or BIOTC Majors

Completion of 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.
Special Options within the Major

The department offers two options under the B.S. degree program in Biochemistry and Molecular Biology and in Biotechnology. The choice of an option depends on your own interests as well as on your career plans. It is an important choice because course requirements differ substantially. The differences, for the most part, are only in the junior and senior years. This means you can put off the choice of an option until as late as your fifth semester. If possible, this decision should not be made much later. Descriptions of the different options are given later in this handbook. You are encouraged to talk to your adviser for more information.

Supporting Courses

These are optional courses that students may select. You can use these courses to fulfill requirements for a minor in another subject. You will find these listed on your major check sheet.

General Education

Every student must take 45 credits of General Education courses. The course selections are designed to provide a well-rounded academic experience within an integrated curriculum that allows for individual flexibility. General Education courses may be relevant to your major or to your particular interests. The baccalaureate degree General Education program consists of two components: (1) skills, and (2) knowledge domains for a total of 45 credits. The skills component includes writing/speaking (9 credits) and quantification (6 credits). The knowledge domains include health and physical activity (3 credits), natural science (9 credits), arts (6 credits), humanities (6 credits), and social and behavioral sciences (6 credits). For a complete listing of all approved courses in the skills and knowledge domains, please refer to the website: http://bulletins.psu.edu/bulletins/bluebook/general_education.cfm

United States Cultures and International Cultures Requirement

Students admitted to baccalaureate degree must complete 3 credits in Unites States Cultures (US) and 3 credits in International Cultures (IL). If a student takes a 3-credit course that is both US and IL, he/she must take another 3-credit course that is US, IL, or both US and IL to complete the requirement. Education abroad courses and other credit-bearing experiences such as internships that meet this requirement will be designated as US, IL, or both US and IL.

Foreign/Second Language Admission Requirement

A student can be admitted to a baccalaureate degree program whether or not he/she has completed two units of a single foreign/second language at the high school level. However, if a student has not attained this level of language prior to admission, he/she must correct this deficiency by the time he/she earns 60 credits.

This requirement applies to transfer students, students moving to baccalaureate programs after completing associate degree programs, and students entering directly from high school. This requirement does not apply to students who can demonstrate fluency in a foreign/second language.

To determine if a student has met this admission requirement, "OK" will be printed next to the statement, "HIGH SCHOOL FOREIGN/SECOND LANGUAGE ADMISSION REQUIREMENT." "NO" precedes the statement if a student has not met the requirement.

If you have not met the requirement, see http://www.psu.edu/dus/handbook/langadmreq.html
Concurrent Majors

Two programs—two degrees. Concurrent majors and sequential majors—allow a baccalaureate or associate degree candidate to earn degrees in more than one Penn State major. When completing concurrent majors, the student simultaneously completes all academic requirements for his/her majors and graduates with two (or more) degrees in the same semester.

Some concurrent majors have been combined in an established curriculum with specified entrance and graduation requirements. A candidate receiving approval from the colleges involved may gain entrance to more than one major. The idea of majoring in two areas to broaden one's knowledge is a good one, but such a program requires ability and diligence. Anyone interested in pursuing a second major should first speak with the director of undergraduate programs in both of the departments concerned. The final academic record shall indicate the completion of the requirements for each major. For more information, see http://dus.psu.edu/handbook/concurrent.html

Minors in other Disciplines

Students are strongly encouraged to consider minors in fields outside of their discipline. For a listing of available minors, visit the website http://www.psu.edu/dus/handbook/minors2.html

Honors Courses and the University Scholars Program

Several hundred of the most talented Penn State undergraduates are in the University Scholars Program. For incoming students, admission to this program is by a separate application reviewed by the Faculty Selection Committee. For students already here, admission to the program is on the basis of cumulative grade point average or, in some cases, by faculty nomination. To graduate in the program, a student must maintain a high average every semester, take a minimum number of credits in courses with an Honors designation, and write an Honors Thesis. More information about the Scholars Program is available at the Program Office in 10 Atherton Hall, Schreyer Honors College or at http://www.shc.psu.edu/. The biochemistry and molecular biology department teaches Honors sections of several courses. It is possible for a student not in the Scholars Program to enroll in Honors sections. For more information, schedule an appointment with Director of Undergraduate Studies, Dr. James Howell by phone 814-865-7736 or email him at jhowell@psu.edu or with Dr. Sarah Ades, Chair BMB Honor Advisers, 406 Althouse, sea10@psu.edu.

The Minor in Biochemistry & Molecular Biology

To earn the BMB minor, students must take the following prescribed courses: B M B251 (3), B M B 252 (3), B M B 442 (3), B M B 400 (2), B M B 401 (3), B M B 402 (3) plus one other course from 400-level BMB course offering for total of ≥ 18 credits. Note students may not use Independent Research (496) of Lab Instructor Practice (408) as an elective for the minor. A grade of “C” or better is required in ALL courses that apply to the minor. For more information, go to: http://bmb.psu.edu/undergraduate/bmb-majors/bmb-minor

The Minor in Microbiology

To earn the MICRB minor, students must take the following prescribed courses: MICRB 201 (3), MICRB 202 (2), MICRB 251 (3), MICRB 410 (3), MICRB 421W (3) or MICRB 422 (2), along with 4-5 credits of 400-level Microbiology course for a total of ≥ 18 credits. Note the following courses are not accepted in this category: BMB/ MICRB 442, MICRB 400, 408, 496, or 497. A grade of “C” or better is required in ALL courses that apply to the minor. To find out more, go to: http://bmb.psu.edu/undergraduate/bmb-majors/micrb-minor
Evaluation of Courses from Other Universities

Each student who applies for courses to be transferred to Penn State is required to have a transcript sent to the Office of Admissions, where it is evaluated. When a course taken elsewhere is deemed equivalent to a course given at Penn State, credit for that specific Penn State course is assigned and an entry made in the “Number” column. If such a correspondence cannot be made, general credits (denoted “GEN” in the “CREDITS” column) are assigned as appropriate. The general credit designation does not imply that the credits cannot be transferred, but merely that Penn State Undergraduate Admissions is unable to establish the degree of similarity between a course taken elsewhere and a course offered at Penn State. The general credit designation implies that the student has the responsibility for obtaining assessments of course equivalencies “as appropriate”. The determination of “appropriateness” is left to the individual colleges. For the Eberly College of Science, the policy depends on the type of course for which general credit has been assigned.

Degree Audit

The degree audit is an academic advising document that maps a student’s degree requirements against their academic transcript. The purpose of the audit is to provide information to assist in academic planning and appropriate course scheduling.

* Degree audits are available to all currently enrolled undergraduate degree students by accessing eLion or request a current audit on a "walk-in" basis from their department office, advising center, or campus registrar.

* Students with more than one major/option or with minors will have separate audits produced for each program.

* Students thinking about changing their major or adding a minor can request a "what if" audit. This audit will assist in determining how courses they have already completed would apply to the new major or minor and what courses they would need to complete.

If a student feels that their audit is not correctly analyzing their program requirements, they should contact their department office or advising center. Here is a link on how to interpret your degree audit: http://www.registrar.psu.edu/degree_audit/degree_audit_ex/degree_audit_ex.cfm

Career-Related Experience and Study Abroad Opportunities

Science Job Shadowing/Externship Program (First-Year, Sophomore Year)

Get a first-hand perspective on possible careers by registering for a job shadowing/externship during your freshman and/or sophomore years. The shadowing lasts one to four days; most students choose something close to your home since the shadowing happens after you’ve left school for the summer. You choose your top three favorites from the list of Penn State alumni extern hosts/sites, and you’ll be matched with one of them. To apply, visit http://cie.science.psu.edu.

Science Cooperative Education (Junior/Senior Years)

Co-op gives you extended work experience related to your major, while earning academic credit, and getting paid. It’s a win-win-win! You do three co-op “rotations” before graduation, and at least one has to be completed during the fall or spring semester. Most students do a summer/fall or spring/summer assignment and then another summer. You don’t have to complete all three co-ops with the same organization, so it’s a great chance to get experience in a few different environments. You can use your co-op credits to meet course requirements, so plan ahead and talk with your adviser about how you can fit co-op into your degree. For more information, visit http://science.psu.edu/cie/co-op
Science Internship
You can use the Career and International Education web-based database to search for opportunities and get leads on possible summer programs. Office staff will review your resume and cover letters, and answer your questions about applications. Then, you simply apply on-line to the organization web sites. Remember – summer is competitive, because you’re in the same applicant pool as everyone in the country, so you need to plan ahead and search for opportunities early. If you want to earn academic credit for your internship, complete and return the Request for Academic Credit form at http://science.psu.edu/cie/internship. If not, please let the Career and International Education staff know about your position, so they can track the data for their annual report.

International Opportunities
You have a lot of chances to get international experience during your time at Penn State. If you want to take upper-level courses abroad, there are places where you can do that. If you’re interested in studying a language, taking gen eds, or visiting some particular country or culture, The University of Global Programs offers almost 200 different study abroad options for Penn State students. If you’d like to get research experience abroad, there are several international REU (Research Experience for Undergraduates) programs available. If you’re not sure about studying abroad for a full semester, then you may want to look at the summer program options, or check out the embedded courses, which are courses that are offered here on campus during the regular semester, but that include some international travel component. A complete list of all study abroad programs and embedded courses can be found at www.global.psu.edu, and more science-specific information about international opportunities can be found at http://cie.science.psu.edu. You can visit either office at any point to get more information and to explore your options, but plan early, because most programs require early applications, and you should talk with your advisor about how you want to fit an international experience into your major.

Career Related Resources
Don’t have a resume or cover letter? Click “Career Exploratin” on the Career & International Education web site at http://cie.science.psu.edu for samples and advice on getting an internship, co-op or full-time job. Please visit the Career and International Education Office in 112 Ritenour Building or call 814.865.5000 for more information about gaining career-related or international experience.
The Bachelor of Science Degree in Biochemistry and Molecular Biology

Biochemistry and Molecular Biology is the most physical science-oriented of the three majors offered by the BMB department. While most of the foundation science courses are common to all three majors, the BMB major emphasizes the physical sciences to a greater extent than the department’s other two majors. This explains the requirements for the calculus-based physics sequence, the year-long physical chemistry sequence and the additional quantification course that are specific to the Biochemistry option in this major. Advanced electives include courses with a distinct molecular and cell biology emphasis. The major provides excellent preparation for graduate and professional schools. Graduates are very well received by industry.

Biochemistry & Molecular Biology with the Biochemistry Option (125 credits)

1. GENERAL EDUCATION
   ARTS (6 cr)
   ______________________(GA) 3 crs
   ______________________(GA) 3 crs
   ______________________(GA) 3 crs

   HUMANITIES (6 cr)
   ______________________(GH) 3 crs
   ______________________(GH) 3 crs
   ______________________(GH) 3 crs

   SOCIAL & BEHAVIORAL SCIENCES (6 cr)
   ______________________(GS) 3 crs
   ______________________(GS) 3 crs
   ______________________(GS) 3 crs

   Students may petition to substitute 3 credits from one of the above knowledge domains for 3 credits in another domain, thereby substituting 9-6-3 credit pattern for the default 6-6-6 pattern in these general education courses.

   COMMUNICATIONS (GWS) (9 cr)
   _____ENGL 015 or 030: Rhetoric & Comp 3 crs
   _____ENGL 202C: Technical Writing 3 crs
   _____CAS 100 A, B or C: Effective Speech 3 crs

   HEALTH & PHYSICAL ACTIVITIES (3 cr)
   ______________________(GHA or GHS or GPE) crs
   ______________________(GHA or GHS or GPE) crs
   ______________________(GHA or GHS or GPE) crs

   WRITING ACROSS the CURRICULUM (W) (3cr)
   ______________________(W) 3 crs

   US/INTERNATIONAL CULTURES (6 cr)
   ______________________(US) 3 crs
   ______________________(IL) 3 crs
## Degree Requirements

### 2. REQUIREMENTS FOR THE MAJOR

#### CHEMISTRY (22 cr)
- **CHEM 110: (H): Chemical Principles I** 3
- **CHEM 111: Experimental Chemistry I** 1
- **CHEM 112: (H): Chemical Principles II** 3
- **CHEM 113: Experimental Chemistry II** 1
- **CHEM 210: (H): Organic Chemistry I** 3
- **CHEM 212: (H): Organic Chemistry II** 3
- **CHEM 213: Organic Chemistry Lab** 2
- **CHEM 450: Physical Chemistry and** 3
- **CHEM 452: Physical Chemistry** 3

#### BIOCHEMISTRY & MOLECULAR BIOLOGY (25 cr)
- **BMB 251: Molecular & Cell Biology I** 3
- **BMB 252: Molecular & Cell Biology II** 3
- **BMB 400: Molec. Biol. of the Gene** 2
- **BMB 401: General Biochemistry** 3
- **BMB 402: General Biochemistry** 3
- **BMB 442: Lab Prot, Nuc Acid, Molec Clon** 3
- **BMB 443W: Lab Protein Purifi./Enzymo** 3
- **BMB 445W: Lab Molecular Genetics** 2
- **BMB 474: Analytical Tech in BMB** 3

#### MICROBIOLOGY (5 cr)
- **MICRB 201: Intro. Microbiology** 3
- **MICRB 202: Intro. Microbiology Lab** 2

#### MATHEMATICS (8 cr)
- **MATH 140: Calculus I** 4
- **MATH 141: Calculus II** 4

#### BIOLOGY (3 cr)
- **BIOL 322: Genetic Analysis** 3

#### PHYSICS SEQUENCE (12 cr)
- **PHYS 211: Gen Phys: Mechanics** 4
- **PHYS 212: Gen Phys: Elec./Magnet.** 4
- **PHYS 213: Gen Phys: Fluids/Thermal** 2
- **PHYS 214: Gen Phys:Wave/Motion/Qu** 2

#### FIRST YEAR SEMINAR (1 cr)
- **PSU 016: First Year Seminar Science** 1

All of the above courses are **required** for the Biochemistry & Molecular Biology Major, Biochemistry option.

*Note: a “C” or better grade is required in CHEM 110, 111, 112, MATH 140 and at least 2 of the following BMB 251, 252 or MICRB 201

Total Major Requirement Credits:__________
3. **ELECTIVES IN THE MAJOR**

   LIST A select **7-9 credits** from any 400 level BMB/MICRB/CHEM course with a total maximum of 4-credits in BMB 488 and/or 496:

   
   ______________________   _______crs
   ______________________   _______crs
   ______________________   _______crs
   ______________________   _______crs

   Total LIST A credits ______

4. **MATHEMATICAL SCIENCE**

   LIST B select **2-3 credits** from:

   
   _____CmpSc 101 3
   _____Stat 250 3
   _____Math 220 2
   _____Stat 301 3
   _____Math 231 2
   _____Stat 401 3
   _____Math 250 3

   Students should select 2-3 credits from the electives List B to fulfill the Mathematical Science area.

   Total List B Credits:__________

5. **LIST C FREE ELECTIVES**

   Select **7-10 credits** from Department List

   
   ______________________   _______crs
   ______________________   _______crs
   ______________________   _______crs
   ______________________   _______crs

   **LIST C FREE ELECTIVES** - With the EXCEPTION of the courses listed below, ALL courses appearing in the University Bulletin are acceptable as elective courses: 6 credits of ROTC may be applied toward graduation requirements.

   Students MAY NOT fulfill this requirement with lower level or general education courses in math and science (including but not limited to examples such as: any BI SC course, any B M B course below the 100 level, MATH 110 and 111, and the like).

   Students MAY NOT fulfill this requirement with courses that significantly repeat material from courses required for the major, (including but not limited to examples such as: CHEM 202 or 203 after taking CHEM 210 or 212, or vice-versa; PHYS 250 or 251 after taking PHYS 211, 212, 213, and 214, or vice-versa; and so forth).

   Students MAY NOT fulfill this requirement with remedial courses (including but not limited to examples such as: LL ED 005 and 010; ENGL 004, 005, and 006; CHEM courses below CHEM 110; MATH courses below MATH 110; STAT 100; PHYS courses below PHYS 211; and the like).

   Total Free Elective Credits: ___________
6. ENTRANCE TO MAJOR

A student enrolled in this major must receive a grade “C” or better in the following courses specified by Senate Policy 82-44

_____ CHEM 110(H): Chemical Principles I 3
_____ CHEM 111: Experimental Chemistry I 1
_____ CHEM 112 (H): Chemical Principles II 3
_____ MATH 140: Calculus I 4

2.0 GPA is required

7. TO GRADUATE

A “C” grade or better is required in 2 of the following 3 courses. **All 3 courses are required.**

_____ MICRB 201: Intro. Microbiology 3
_____ BMB 251: Molecular & Cell Biology I 3
_____ BMB 252: Molecular & Cell Biology II 3

Total ≥ 9

+ Earn “C” or Higher in **9 credits** of any 400-level MICRB/BMB courses **except** BMB 442, 443W, 445W, 448, 488, 496, MICRB 421W, 422, 447

____________________  ____ crs
____________________  ____ crs
____________________  ____ crs
____________________  ____ crs

Total ≥ 9

8. REMEDIAL & REPEATS

Courses that do not meet degree requirements:

____________________  ____ crs
____________________  ____ crs
____________________  ____ crs
____________________  ____ crs

9. SENATE POLICY 8380

10. GPA/CREDITS

Source/Time Credit acquisition:
36 of last 60 credits at PSU? ________ crs
60 credits in last 5 years? ________ crs

Overall GPA must be ≥ 2.0: __________

Total Credits Earned (less repeats and remedial; must have at least 125 to graduate): __________

11. University Activities/Awards

12. Program Exceptions:

BMB - Biochemistry Option
## Degree Requirements
### Recommended Academic Plan
**Biochemistry and Molecular Biology with Biochemistry Option**
**B M B with Bioch option at UP**
**Effective (For students entering Fall 2012 and later)**

<table>
<thead>
<tr>
<th>Semester 1</th>
<th>Credits</th>
<th>Semester 2</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>~ MATH 140 (GQ) Calculus with Analytic Geometry I</td>
<td>4</td>
<td>~ MATH 141(GQ) Calculus with Analytic Geometry II</td>
<td>4</td>
</tr>
<tr>
<td>~ CHEM 110 (GN) Chemical Principles</td>
<td>3</td>
<td>~ CHEM 112 (GN) Chemical Principles</td>
<td>3</td>
</tr>
<tr>
<td>~ CHEM 111 (GN) Experimental Chemistry</td>
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<td>CHEM 113(GN) Experimental Chemistry</td>
<td>1</td>
</tr>
<tr>
<td>PSU 016 First-Year Seminar</td>
<td>1</td>
<td>% MICRB 201 Introductory Microbiology</td>
<td>3</td>
</tr>
<tr>
<td>Art (GA), Humanities (GH), or Social Behavioral Sciences (GS)</td>
<td>3</td>
<td>MICRB 202 Introductory Microbiology Laboratory</td>
<td>2</td>
</tr>
<tr>
<td>~ ENGL 15 (30) Rhetoric and Composition (GWS)</td>
<td>3</td>
<td>^ CAS 100 A, B, or C (GWS) Effective Speech</td>
<td>3</td>
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<tr>
<td>Total Credits:</td>
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<td>Total Credits:</td>
<td>16</td>
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<th>Semester 4</th>
<th>Credits</th>
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<tr>
<td>CHEM 210 Organic Chemistry</td>
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<td>CHEM 212 Organic Chemistry</td>
<td>3</td>
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<tr>
<td>PHYS 211 (GN) General Physics: Mechanics</td>
<td>4</td>
<td>CHEM 213 Laboratory in Organic Chemistry</td>
<td>2</td>
</tr>
<tr>
<td>% BMB 251 Molecular &amp; Cell Biology I</td>
<td>3</td>
<td>PHYS 212 (GN) General Physics: Electricity And Magnetism</td>
<td>4</td>
</tr>
<tr>
<td>± LIST C FREE ELECTIVES</td>
<td>3</td>
<td>% BMB 252 Molecular &amp; Cell Biology II</td>
<td>3</td>
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<tr>
<td>Art (GA), Humanities (GH), or Social Behavioral Sciences (GS)</td>
<td>3</td>
<td>BIOL 322 Genetic Analysis</td>
<td>3</td>
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<td>Total Credits:</td>
<td>16</td>
<td>Total Credits:</td>
<td>15</td>
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<th>Semester 5</th>
<th>Credits</th>
<th>Semester 6</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>BMB 400 Molecular Biology of the Gene</td>
<td>2</td>
<td>BMB 402 General Biochemistry</td>
<td>3</td>
</tr>
<tr>
<td>BMB 401 General Biochemistry</td>
<td>3</td>
<td>BMB 445W Laboratory in Molecular Genetics or B M B 448 Model Systems and Approaches in Cell Biology Inquiry</td>
<td>2</td>
</tr>
<tr>
<td>BMB 442 Lab in Proteins, Nucleic Acids, &amp; Molecular Cloning</td>
<td>3</td>
<td>CHEM 452 Physical Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 450 Physical Chemistry</td>
<td>3</td>
<td>Art (GA), Humanities (GH), or Social Behavioral Sciences (GS)</td>
<td>6</td>
</tr>
<tr>
<td>PHYS 213 (GN) General Physics: Fluids and Thermal Physics</td>
<td>2</td>
<td>Health &amp; Physical Activity (GHA)</td>
<td>1.5</td>
</tr>
<tr>
<td>PHYS 214 (GN) General Physics: Wave Motion &amp; Quantum Physics</td>
<td>2</td>
<td></td>
<td></td>
</tr>
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<td>Total Credits:</td>
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<td>15.5</td>
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<th>Semester 7</th>
<th>Credits</th>
<th>Semester 8</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMB 443W Laboratory in Protein Purification &amp; Enzymology</td>
<td>3</td>
<td>BMB 474 Analytical Techniques in BMB</td>
<td>3</td>
</tr>
<tr>
<td># BMB, CHEM or MICRB 400 Level Course</td>
<td>3-6</td>
<td>ENGL 202C (GWS) Technical Writing</td>
<td>3</td>
</tr>
<tr>
<td>^ LIST B ELECTIVE</td>
<td>2-3</td>
<td># BMB, CHEM or MICRB 400 Level Course</td>
<td>3-6</td>
</tr>
<tr>
<td>Art (GA), Humanities (GH), or Social Behavioral Sciences (GS)</td>
<td>3</td>
<td>± LIST C FREE ELECTIVES</td>
<td>1-7</td>
</tr>
<tr>
<td>Health &amp; Physical Activity (GHA)</td>
<td>1.5</td>
<td>Art (GA), Humanities (GH), or Social Behavioral Sciences (GS)</td>
<td>3</td>
</tr>
<tr>
<td>Total Credits:</td>
<td>12.5-16.5</td>
<td>Total Credits:</td>
<td>13-17</td>
</tr>
</tbody>
</table>

- **Bold** type indicates courses requiring a quality grade of C or better.
- **Italic** type indicates courses that satisfy both major and General Education requirements.
- **Italic Bold** type indicates courses requiring a quality grade of C or better and that satisfy both major and General Education requirements.
- **GWS, GHA, GQ, GN, GA, GH, and GS are codes used to identify General Education requirements.**
- **US, IL, and US;IL are codes used to designate courses that satisfy University United States/International Cultures requirement.**
- **W is the code used to designate courses that satisfy University Writing Across the Curriculum requirements.**
- ~ indicates courses required to enter into this major.
- % indicates all 3 courses are required to graduate; a quality grade of C or better is required in 2 of the 3 courses.
- # indicates List B Electives: CMPSC 101 (3), 201 (3), Math 220 (2), 231 (2), 250 (3), Stat 250 (3) 301 (3), 401 (3)
- ± indicates see the Department List C for exclusions see reverse side
- ^ indicates honor students should schedule ENGL/CAS 137H in the fall and ENGL/CAS 138T in the spring. The sequence should be completed in the first year.
- To graduate, all students must earn C or higher in 9 credits of any 400-level BMB/MICRB courses except BMB 442, 443W, 445W, 446, 488, 496, MICRB 421W, 422, 447

**BMB - Biochemistry Option**
Degree Requirements

Scheduling patterns for courses not taught each semester
Fall - only taught courses: BMB 251H, 400, 401H, 428, 430, 443W, 448, 464 BMB/MICRB 435, 450 MICRB 401, 413, 421W and MICRB/BIOTC 416


± LIST C FREE ELECTIVES - With the EXCEPTION of the courses listed below, ALL courses appearing in the University Bulletin are acceptable as elective courses: 6 credits of ROTC may be applied toward graduation requirements.

Students MAY NOT fulfill this requirement with lower level or general education courses in math and science (including but not limited to examples such as: any BI SC course, any B M B course below the 100 level, MATH 110 and 111, and the like).

Students MAY NOT fulfill this requirement with courses that significantly repeat material from courses required for the major, (including but not limited to examples such as: CHEM 202 or 203 after taking CHEM 210 or 212, or vice-versa; PHYS 250 or 251 after taking PHYS 211, 212, 213, and 214, or vice-versa; and so forth).

Students MAY NOT fulfill this requirement with remedial courses (including but not limited to examples such as: LL ED 005 and 010; ENGL 004, 005, and 006; CHEM courses below CHEM 110; MATH courses below MATH 110; STAT 100; PHYS courses below PHYS 211; and the like).
Degree Requirements

The Bachelor of Science Degree in Biochemistry and Molecular Biology with the Molecular and Cellular Biology Option (125 credits)

BMB MCB Option Check Sheet (125 credits)

1. GENERAL EDUCATION

    ARTS (6 cr)
    ______________________(GA) 3 crs
    ______________________(GA) 3 crs
    ______________________(GA) 3 crs

    HUMANITIES (6 cr)
    ______________________(GH) 3 crs
    ______________________(GH) 3 crs
    ______________________(GH) 3 crs

    SOCIAL & BEHAVIORAL SCIENCES (6 cr)
    ______________________(GS) 3 crs
    ______________________(GS) 3 crs
    ______________________(GS) 3 crs

Students may petition to substitute 3 credits from one of the above knowledge domains for 3 credits in another domain, thereby substituting 9-6-3 credit pattern for the default 6-6-6 pattern in these general education courses.

    COMMUNICATIONS (GWS) (9 cr)
    _____ ENGL 015 or 030: Rhetoric & Comp 3 crs
    _____ ENGL 202C: Technical Writing 3 crs
    _____ CAS 100 A, B or C: Effective Speech 3 crs

    HEALTH & PHYSICAL ACTIVITIES (3 cr)
    ______________________(GHA or GHS or GPE) ____ crs
    ______________________(GHA or GHS or GPE) ____ crs
    ______________________(GHA or GHS or GPE) ____ crs

    WRITING ACROSS the CURRICULUM (W) (3 cr)
    ______________________(W) 3 crs

    US/INTERNATIONAL CULTURES (6 cr)
    ______________________(US) 3 crs
    ______________________(IL) 3 crs

Total General Education Credits:__________
## Degree Requirements

### 2. REQUIREMENTS FOR THE MAJOR

**CHEMISTRY (16 cr)**
- *CHEM 110: (H): Chemical Principles I 3
- *CHEM 111: Experimental Chemistry I 1
- *CHEM 112: (H): Chemical Principles II 3
- CHEM 113: Experimental Chemistry II 1
- CHEM 210: (H): Organic Chemistry I 3
- CHEM 212: (H): Organic Chemistry II 3
- CHEM 213: Organic Chemistry Lab 2

**PHYSICAL CHEMISTRY SEQUENCE (3 or 6 cr)**
- CHEM 450: Physical Chemistry and 3
- CHEM 452: Physical Chemistry 3
  - or
- BMB 428 Physical Chemistry with 3
  Biological Applications

**BIOCHEMISTRY & MOLECULAR BIOLOGY (28 cr)**
- *BMB 251: Molecular & Cell Biology I 3
- *BMB 252: Molecular & Cell Biology II 3
- BMB 400: Molecular Biol. of the Gene 2
- BMB 401: General Biochemistry 3
- BMB 402: General Biochemistry 3
- BMB 430: Developmental Biology 3
- BMB 442: Lab Prot, Nuc Acid, Molec Clon 3
- BMB 443W: Lab Protein Purifi./Enzymo 3
- BMB 445W: Lab Molecular Genetics 2
- BMB 460: Cell Growth & Differentiation 3

**MICROBIOLOGY (8 cr)**
- *MICRB 201: Intro. Microbiology 3
- MICRB 202: Intro. Microbiology Lab 2
- MICRB 410: Principles of Immunology 3

**MATHEMATICS (8 cr)**
- *MATH 140: Calculus I 4
- MATH 141: Calculus II 4

**BIOLOGY (3 cr)**
- BIOL 322: Genetic Analysis 3

**PHYSICS SEQUENCE (8)**
- PHYS 250: Intro Physics I 4
- PHYS 251: Intro Physics II 4

**FIRST YEAR SEMINAR (1 cr)**
- PSU 016: First Year Seminar Science 1

---

All courses on this page are **required** for the Biochemistry and Molecular Biology Major, Molecular and Cellular Biology option.

1) in place of PHYS 250 & 251, you may elect to take PHYS 211(4) 3rd semester; PHYS 214(4) 4th semester and PHYS 213 (2) & PHYS 214 (2) 5th semester.

2) student should take one of the two sequences: CHEM 450 & 452 or take BMB 428.

*Note: a "C" or better grade is required in CHEM 110, 111, 112, MATH 140 and at least 2 of the following BMB 251, 252 or MICRB 201

Total Major Requirement Credits:__________
LIST A select **5-6 credits** from any 400 level BMB/MICRB course with a maximum of 4-credits in 488 and/or 496:

____________________  crs
____________________  crs
____________________  crs
____________________  crs

Total LIST A credits _____

4. MATHEMATICAL SCIENCE

LIST B select **2-3 credits** from:

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CmpSc 101</td>
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</tr>
<tr>
<td>Stat 250</td>
<td>3</td>
</tr>
<tr>
<td>Math 220</td>
<td>2</td>
</tr>
<tr>
<td>CmpSc 201</td>
<td>3</td>
</tr>
<tr>
<td>Stat 301</td>
<td>3</td>
</tr>
<tr>
<td>Math 231</td>
<td>2</td>
</tr>
<tr>
<td>Stat 401</td>
<td>3</td>
</tr>
<tr>
<td>Math 250</td>
<td>3</td>
</tr>
</tbody>
</table>

Students should select 2-3 credits from the electives List B to fulfill the Mathematical Science area.

Total List B Credits:________

5. LIST C FREE ELECTIVES

Select **4-13 credits** from Department List

____________________  crs
____________________  crs
____________________  crs
____________________  crs

LIST C FREE ELECTIVES - With the EXCEPTION of the courses listed below, ALL courses appearing in the University Bulletin are acceptable as elective courses: 6 credits of ROTC may be applied toward graduation requirements.

Students **MAY NOT** fulfill this requirement with lower level or general education courses in math and science (including but not limited to examples such as: any BI SC course, any B M B course below the 100 level, MATH 110 and 111, and the like).

Students **MAY NOT** fulfill this requirement with courses that significantly repeat material from courses required for the major, (including but not limited to examples such as: CHEM 202 or 203 after taking CHEM 210 or 212, or vice-versa; PHYS 250 or 251 after taking PHYS 211, 212, 213, and 214, or vice-versa; and so forth).

Students **MAY NOT** fulfill this requirement with remedial courses (including but not limited to examples such as: LL ED 005 and 010; ENGL 004, 005, and 006; CHEM courses below CHEM 110; MATH courses below MATH 110; STAT 100; PHYS courses below PHYS 211; and the like).

Total Free Elective Credits:________
# Degree Requirements

## 6. ENTRANCE TO MAJOR

A student enrolled in this major must receive a grade “C” or better in the following courses specified by Senate Policy 82-44

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 110(H)</td>
<td>Chemical Principles I</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 111</td>
<td>Experimental Chemistry I</td>
<td>1</td>
</tr>
<tr>
<td>CHEM 112(H)</td>
<td>Chemical Principles II</td>
<td>3</td>
</tr>
<tr>
<td>MATH 140</td>
<td>Calculus I</td>
<td>4</td>
</tr>
</tbody>
</table>

2.0 GPA is required

## 7. TO GRADUATE

A “C” grade or better is required in 2 of the following 3 courses. **All 3 courses are required.**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MICRB 201</td>
<td>Intro. Microbiology</td>
<td>3</td>
</tr>
<tr>
<td>BMB 251</td>
<td>Molecular &amp; Cell Biology I</td>
<td>3</td>
</tr>
<tr>
<td>BMB 252</td>
<td>Molecular &amp; Cell Biology II</td>
<td>3</td>
</tr>
</tbody>
</table>

Total ≥ 9

+ Earn “C” or Higher in 9 credits of any 400-level MICRB/BMB courses except BMB 442, 443W, 445W, 448, 488, 496, MICRB 421W, MICRB 422, MICRB 447

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
</table>

Total ≥ 9

## 8. REMEDIAL & REPEATS

Courses that do not meet degree requirements:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
</table>

## 9. SENATE POLICY 8380

Source/Time Credit acquisition:

- 36 of last 60 credits at PSU? _________crs
- 60 credits in last 5 years? _________crs

## 10. GPA/CREDITS

Overall GPA must be ≥ 2.0: __________

Total Credits Earned (less repeats and remedial; must have at least 125 to graduate): _________

## 11. University Activities/Awards

## 12. Program Exceptions:

BMB - Molecular and Cellular Biology Option
## Recommended Academic Plan

**Biochemistry and Molecular Biology with Molecular & Cell Biology Option**
(B MB with MCB option at UP)

**Effective (For students entering Fall 2012 and later)**

<table>
<thead>
<tr>
<th>Semester 1</th>
<th>Credits</th>
<th>Semester 2</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>~ MATH 140 (GQ) Calculus with Analytic Geometry I</td>
<td>4</td>
<td>~ MATH 141(GQ) Calculus with Analytic Geometry II</td>
<td>4</td>
</tr>
<tr>
<td>~ CHEM 110 (GN) Chemical Principles</td>
<td>3</td>
<td>~ CHEM 112 (GN) Chemical Principles</td>
<td>3</td>
</tr>
<tr>
<td>~ CHEM 111 (GN) Experimental Chemistry</td>
<td>1</td>
<td>CHEM 113(GN) Experimental Chemistry</td>
<td>1</td>
</tr>
<tr>
<td>PSU 016 First-Year Seminar</td>
<td>1</td>
<td>% MICRB 201 Introductory Microbiology</td>
<td>3</td>
</tr>
<tr>
<td>Art (GA), Humanities (GH), or Social Behavioral Sciences (GS)</td>
<td>3</td>
<td>MICRB 202 Introductory Microbiology Laboratory</td>
<td>2</td>
</tr>
<tr>
<td>^ ENGL 15 (30) Rhetoric and Composition (GWS)</td>
<td>3</td>
<td>^ CAS 100 A, B, or C (GWS) Effective Speech</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total Credits:</strong> 15</td>
<td></td>
<td><strong>Total Credits:</strong> 16</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester 3</th>
<th>Credits</th>
<th>Semester 4</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 210 Organic Chemistry</td>
<td>3</td>
<td>CHEM 212 Organic Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>% PHYS 250 Introductory Physics I (must be taken in sequence with PHYS 251)</td>
<td>4</td>
<td>&amp; PHYS 251 Introductory Physics II (must be taken in sequence with PHYS 250)</td>
<td>4</td>
</tr>
<tr>
<td>^ LIST B ELECTIVE</td>
<td>2-3</td>
<td>% BMB 252 Molecular &amp; Cell Biology II</td>
<td>3</td>
</tr>
<tr>
<td>Art (GA), Humanities (GH), or Social Behavioral Sciences (GS)</td>
<td>3</td>
<td>BIOL 322 Genetic Analysis</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total Credits:</strong> 15-16</td>
<td></td>
<td><strong>Total Credits:</strong> 15</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester 5</th>
<th>Credits</th>
<th>Semester 6</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMB 400 Molecular Biology of the Gene</td>
<td>2</td>
<td>BMB 402 General Biochemistry</td>
<td>3</td>
</tr>
<tr>
<td>BMB 401 General Biochemistry</td>
<td>3</td>
<td>BMB 445W Laboratory in Molecular Genetics or B M B 448 Model Systems and Approaches in Cell Biology Inquiry</td>
<td>2</td>
</tr>
<tr>
<td>BMB 442 Lab in Proteins, Nucleic Acids, &amp; Molecular Cloning</td>
<td>3</td>
<td>BMB 460 Cell Growth and Differentiation</td>
<td>3</td>
</tr>
<tr>
<td>MICRB 410 Principal of Immunology</td>
<td>3</td>
<td>Art (GA), Humanities (GH), or Social Behavioral Sciences (GS)</td>
<td>6</td>
</tr>
<tr>
<td>± LIST C FREE ELECTIVES</td>
<td>3</td>
<td>Health &amp; Physical Activity (GHA)</td>
<td>1.5</td>
</tr>
<tr>
<td><strong>Total Credits:</strong> 15.5</td>
<td></td>
<td><strong>Total Credits:</strong> 15.5</td>
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</table>

<table>
<thead>
<tr>
<th>Semester 7</th>
<th>Credits</th>
<th>Semester 8</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 450 Physical Chemistry – Thermodynamics (must be taken in sequence with CHEM 452)</td>
<td>3</td>
<td>CHEM 452 Physical Chemistry - Quantum Chemistry (must be taken in sequence with CHEM 450)</td>
<td>3</td>
</tr>
<tr>
<td>BMB 428 Physical Chemistry with Biological Applications</td>
<td>3</td>
<td>ENGL 202C (GWS) Technical Writing</td>
<td>3</td>
</tr>
<tr>
<td>BMB 430 Developmental Biology</td>
<td>3</td>
<td>Art (GA), Humanities (GH), or Social Behavioral Sciences (GS)</td>
<td>0-3</td>
</tr>
<tr>
<td># BMB or MICRB 400 Level Course</td>
<td>2-3</td>
<td># BMB or MICRB 400 Level Course</td>
<td>2-3</td>
</tr>
<tr>
<td>Art (GA), Humanities (GH), or Social Behavioral Sciences (GS)</td>
<td>3</td>
<td>± LIST C FREE ELECTIVES</td>
<td>5-6</td>
</tr>
<tr>
<td><strong>Total Credits:</strong> 14-15</td>
<td></td>
<td><strong>Total Credits:</strong> 13-18</td>
<td></td>
</tr>
</tbody>
</table>

- **Bold** type indicates courses requiring a quality grade of C or better.
- **Italic** type indicates courses that satisfy both major and General Education requirements.
- **Italic Bold** type indicates courses requiring a quality grade of C or better and that satisfy both major and General Education requirements.
- GWS, GHA, GN, GA, GH, and GS are codes used to identify General Education requirements.
- US, IL, and US;IL are codes used to designate courses that satisfy University United States/International Cultures requirement.
- W is the code used to designate courses that satisfy University Writing Across the Curriculum requirements.
- ~ indicates courses required to enter into this major.
- % indicates all 3 courses are required to graduate; a quality grade of C or better is required in 2 of the 3 courses.
- * any 400 level Biochemistry & Molecular Biology (BMB) or Microbiology (MICRB) course with a total maximum of 4-credits in BMB 488 and/or 496.
- * indicates List B Electives: CMPSC 101 (3), 201 (3), Math 220 (2), 231 (2), 250 (3), Stat 250 (3) 301 (3), 401 (3)
- ± indicates see the Department List C for exclusions
- ^ indicates honor students should schedule ENGL/CAS 137H in the fall and ENGL/CAS 138T in the spring. The sequence should be completed in the first year.

~continued next page~
• & indicates in place of PHYS 250 and 251, you may elect to take PHYS 211 (4) 3rd semester; PHYS 212 (4) 4th semester and PHYS 213 (2) & 214 (2) 5th semester.
• To graduate, all students must earn C or higher in 9 credits of any 400-level BMB/ MICRB courses except BMB 442, 443W, 445W, 448, 488, 496, MICRB 421W, 422, 447

Scheduling patterns for courses not taught each semester
Fall - only taught courses:  BMB 251H, 400, 401H, 428, 430, 443W, 448, 464 BMB/MICRB 435, 450 MICRB 401, 413, 421W and MICRB/BIOTC 416


± LIST C FREE ELECTIVES - With the EXCEPTION of the courses listed below, ALL courses appearing in the University Bulletin are acceptable as elective courses: 6 credits of ROTC may be applied toward graduation requirements.

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The Bachelor of Science Degree in Biotechnology

The General Option of the Biotechnology major requires a strong foundation in the sciences and then builds on that foundation with courses that teach students some of the specialized cultural, genetic and molecular techniques used by the biotechnology/biopharmaceutical industries. The heart of the general option consists of a lecture course in industrial microbiology and two, largely laboratory courses that teach students how to grow and genetically modify animal and plant cells. A third laboratory course introduces students to the use of biofermenters and to the team approach that many industries use to develop new products for commercialization. Students who graduate from the general option of the Biotechnology major quickly find employment in the industrial sector and discover that their undergraduate preparation makes the transition from student to employee quite easy.

BIOTC Gen Check Sheet (125 credits)

1. GENERAL EDUCATION
   ARTS (6 cr)
   (GA) 3 crs
   (GA) 3 crs
   (GA) 3 crs

   HUMANITIES (6 cr)
   (GH) 3 crs
   (GH) 3 crs
   (GH) 3 crs

   SOCIAL & BEHAVIORAL SCIENCES (6 cr)
   (GS) 3 crs
   (GS) 3 crs
   (GS) 3 crs

   Students may petition to substitute 3 credits from one of the above knowledge domains for 3 credits in another domain, thereby substituting 9-6-3 credit pattern for the default 6-6-6 pattern in these general education courses.

   COMMUNICATIONS (GWS) (9 cr)
   ENGL 015 or 030: Rhetoric & Comp 3 crs
   ENGL 202C: Technical Writing 3 crs
   CAS 100 A, B or C: Effective Speech 3 crs

   HEALTH & PHYSICAL ACTIVITIES (3 cr)
   (GHA or GHS or GPE) crs
   (GHA or GHS or GPE) crs
   (GHA or GHS or GPE) crs

   WRITING ACROSS the CURRICULUM (W) (3cr)
   (W) 3 crs

   US/INTERNATIONAL CULTURES (6 cr)
   (US) 3 crs
   (IL) 3 crs

   Total General Education Credits:__________

Biotechnology - General Option
## Degree Requirements

### 2. REQUIREMENTS FOR THE MAJOR

**CHEMISTRY (8 cr)**
- *CHEM 110: (H): Chemical Principles I 3*
- *CHEM 111: Experimental Chemistry I 1*
- *CHEM 112: (H): Chemical Principles II 3*
- CHEM 113: Experimental Chemistry II 1

**BIOCHEMISTRY & MOLECULAR BIOLOGY (14 cr)**
- BMB 211: Elementary Biochemistry 3
- BMB 221: Applied Biochemistry 2
- *BMB 251: Molecular & Cell Biology I 3*
- *BMB 252: Molecular & Cell Biology II 3*
- BMB 442: Lab Prot, Nuc Acid, Molec Clon 3

**BIOTECHNOLOGY (11 cr)**
- BIOTC 416: Microbial Biotechnology 2
- BIOTC 459: Plant Tissue Culture Biotc 3
- BIOTC 479: Methods Biofermentations 3
- BIOTC 489: Animal Cell Culture Meth. 3

**MICROBIOLOGY (11 cr)**
- *MICRB 201: Intro. Microbiology 3*
- MICRB 202: Intro. Microbiology Lab 2
- MICRB 410: Principals of Immunology 3
- MICRB 421W: Lab Gen/ Applied Micro 3

**MATHEMATICS (8 cr)**
- *MATH 140: Calculus I 4*
- MATH 141: Calculus II 4

**STATISTICS (3 cr)**
- STAT 250: Introduction Biostatistics 3

**BIOLOGY (3 cr)**
- BIOL 322: Genetic Analysis 3

**PHYSICS (8 cr)**
- PHYS 250: Intro Physics I 4
- PHYS 251: Intro Physics II 4

**FIRST YEAR SEMINAR (1 cr)**
- PSU 016: First Year Seminar Science 1

All of the above courses are **required** for the Biotechnology Major, General Option.

*Note: a “C” or better grade is required in CHEM 110, 111, 112, MATH 140 and at least 2 of the following BMB 251, 252 or MICRB 201

Total Major Requirement Credits:__________
3. ELECTIVES IN THE MAJOR

a. Select 6 or 8 credits from chemistry sequence:

- CHEM 210: (H): Organic Chemistry I 3
- CHEM 212: (H): Organic Chemistry II 3
- CHEM 213: Organic Chemistry Lab 2

or

- CHEM 202: Fund. of Organic Chem I 3
- CHEM 203: Fund. of Organic Chem II 3

+  

b. Select 6 credits from any 400-level BMB/MICRB/BIOTC lecture course or FD SC 408

- ___________  ____________ crs
- ___________  ____________ crs
- ___________  ____________ crs
- ___________  ____________ crs

Total ≥ 6

4. LIST C FREE ELECTIVES

Select 14-16 credits from Department List

- ___________  ____________ crs
- ___________  ____________ crs
- ___________  ____________ crs
- ___________  ____________ crs

LIST C FREE ELECTIVES - With the EXCEPTION of the courses listed below, ALL courses appearing in the University Bulletin are acceptable as elective courses: 6 credits of ROTC may be applied toward graduation requirements.

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Students MAY NOT fulfill this requirement with courses that significantly repeat material from courses required for the major, (including but not limited to examples such as: CHEM 202 or 203 after taking CHEM 210 or 212, or vice-versa; PHYS 250 or 251 after taking PHYS 211, 212, 213, and 214, or vice-versa; and so forth).

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Total Free Elective Credits:__________
### Degree Requirements

#### 5. TO GRADUATE

A "C" grade or better is required in **2** of the following **3** courses. **All 3 courses are required.**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MICRB 201: Intro. Microbiology</td>
<td>3</td>
</tr>
<tr>
<td>BMB 251: Molecular &amp; Cell Biology I</td>
<td>3</td>
</tr>
<tr>
<td>BMB 252: Molecular &amp; Cell Biology II</td>
<td>3</td>
</tr>
</tbody>
</table>

Total ≥ 9

+ Earn "C" or Higher in **9 credits** of any 400-level MICRB/BMB/BIOTC courses except BMB 442, 443W, 445W, 448, 488, 496, MICRB 421W, MICRB 422, MICRB 447

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</tbody>
</table>

Total ≥ 9

#### 6. ENTRANCE TO MAJOR

A student enrolled in this major must receive a grade “C” or better in the following courses specified by Senate Policy 82-44

<table>
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<th>Course</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>CHEM 110(H): Chemical Principles I</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 111: Experimental Chemistry I</td>
<td>1</td>
</tr>
<tr>
<td>CHEM 112 (H): Chemical Principles II</td>
<td>3</td>
</tr>
<tr>
<td>MATH 140: Calculus I</td>
<td>4</td>
</tr>
</tbody>
</table>

**2.0 GPA is required**

#### 7. REMEDIAL & REPEATS

Courses that do not meet degree requirements:

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### 8. SENATE POLICY 8380

Source/Time Credit acquisition:

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>36 of last 60 credits at PSU?</td>
<td>________</td>
</tr>
<tr>
<td>60 credits in last 5 years?</td>
<td>________</td>
</tr>
</tbody>
</table>

8. SENATE POLICY 8380

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Credits</th>
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</thead>
<tbody>
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<td>36 of last 60 credits at PSU?</td>
<td>________</td>
</tr>
<tr>
<td>60 credits in last 5 years?</td>
<td>________</td>
</tr>
</tbody>
</table>

#### 9. GPA/CREDITS

Overall GPA must be ≥ 2.0: ________

Total Credits Earned (less repeats and remedial; must have at least 125 to graduate): ________

#### 10. University Activities/Awards

#### 11. Program Exceptions:
## Recommended Academic Plan
### Biotechnology General Option (BIOTC Gen at UP)
**Effective (For students entering Fall 2012 and later)**

<table>
<thead>
<tr>
<th>Semester 1</th>
<th>Credits</th>
<th>Semester 2</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>~ MATH 140 (GQ) Calculus with Analytic Geometry I</td>
<td>4</td>
<td>MATH 141(GQ) Calculus with Analytic Geometry II</td>
<td>4</td>
</tr>
<tr>
<td>~ CHEM 110(GN) Chemical Principles</td>
<td>3</td>
<td>~ CHEM 112(GN) Chemical Principals</td>
<td>3</td>
</tr>
<tr>
<td>~ CHEM 111 (GN) Experimental Chemistry</td>
<td>1</td>
<td>CHEM 113 (GN) Experimental Chemistry</td>
<td>1</td>
</tr>
<tr>
<td>PSU 016 First-Year Seminar</td>
<td>1</td>
<td>% MICRB 201 Introductory Microbiology</td>
<td>3</td>
</tr>
<tr>
<td>^ ENGL 15 (30) Rhetoric and Composition (GWS)</td>
<td>3</td>
<td>MICRB 202 Introductory Microbiology Laboratory</td>
<td>2</td>
</tr>
<tr>
<td>Arts (GA), Humanities (GH) or Social Behavioral Sciences (GS)</td>
<td>3</td>
<td>^ CAS 100 A, B, or C (GWS) Effective Speech</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total Credits:</strong></td>
<td><strong>15</strong></td>
<td><strong>Total Credits:</strong></td>
<td><strong>16</strong></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester 3</th>
<th>Credits</th>
<th>Semester 4</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 202 (must be taken in sequence with CHEM 203)</td>
<td>3</td>
<td>CHEM 203 (must be taken in sequence with CHEM 202)</td>
<td>3</td>
</tr>
<tr>
<td>or CHEM 210 Organic Chemistry (must be taken in sequence with CHEM 212 &amp; 213)</td>
<td>3</td>
<td>or CHEM 212 Organic Chemistry CHEM 213 Organic Chemistry (must be taken in sequence with CHEM 210 &amp; 212)</td>
<td>2</td>
</tr>
<tr>
<td>% BMB 251 Molecular &amp; Cell Biology I</td>
<td>3</td>
<td>% BMB 252 Molecular &amp; Cell Biology II</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 250 (GN) Introduction Physics I</td>
<td>4</td>
<td>PHYS 251 (GN) Introductory Physics II</td>
<td>4</td>
</tr>
<tr>
<td>Arts (GA), Humanities (GH) or Social Behavioral Sciences (GS)</td>
<td>3</td>
<td>BIOL 322 Genetic Analysis</td>
<td>3</td>
</tr>
<tr>
<td>± LIST C FREE ELECTIVES</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Credits:</strong></td>
<td><strong>16</strong></td>
<td><strong>Total Credits:</strong></td>
<td><strong>13-15</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester 5</th>
<th>Credits</th>
<th>Semester 6</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMB 211 Elementary Biochemistry</td>
<td>3</td>
<td>BMB 221 Applied Biochemistry</td>
<td>2</td>
</tr>
<tr>
<td>MICRB 410 Principles of Immunology</td>
<td>3</td>
<td>BIOTC 459 Plant Tissue Culture &amp; Biotechnology</td>
<td>3</td>
</tr>
<tr>
<td>MICRB 412W Laboratory of General &amp; Applied Microbiology</td>
<td>3</td>
<td>BMB 442 Lab in Proteins, Nucleic Acids, &amp; Molecular Cloning</td>
<td>3</td>
</tr>
<tr>
<td>± LIST C FREE ELECTIVES</td>
<td>3</td>
<td>ENGL 202C Technical Writing</td>
<td>3</td>
</tr>
<tr>
<td>Arts (GA), Humanities (GH) or Social Behavioral Sciences (GS)</td>
<td>3</td>
<td>Health &amp; Physical Activity (GHA)</td>
<td>1.5</td>
</tr>
<tr>
<td>Health &amp; Physical Activity (GHA)</td>
<td>1.5</td>
<td>STAT 250 (GQ) Introduction to Biostatistics</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total Credits:</strong></td>
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<td><strong>Total Credits:</strong></td>
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<tbody>
<tr>
<td>BIOTC 416 Microbial Biotechnology</td>
<td>2</td>
<td>Arts (GA), Humanities (GH) or Social Behavioral Sciences (GS)</td>
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<tr>
<td>Arts (GA), Humanities (GH) or Social Behavioral Sciences (GS)</td>
<td>6</td>
<td># 400 LEVEL ELECTIVE</td>
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<tr>
<td>BIOTC 489 Animal Cell Culture Methods</td>
<td>3</td>
<td>BIOTC 479 Methods in Biofermentations</td>
<td>3</td>
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<tr>
<td># 400 LEVEL ELECTIVE</td>
<td>3</td>
<td>± LIST C FREE ELECTIVES</td>
<td>5-7</td>
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<tr>
<td>± LIST C FREE ELECTIVES</td>
<td>3</td>
<td></td>
<td></td>
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<tr>
<td><strong>Total Credits:</strong></td>
<td><strong>17</strong></td>
<td><strong>Total Credits:</strong></td>
<td><strong>14-16</strong></td>
</tr>
</tbody>
</table>

- Bold type indicates courses requiring a quality grade of C or better.
- Italic type indicates courses that satisfy both major and General Education requirements.
- Italic Bold type indicates courses requiring a quality grade of C or better and that satisfy both major and General Education requirements.
- GWS, GHA, GQ, GN, GA, GH, and GS are codes used to identify General Education requirements.
- US, IL, and US;IL are codes used to designate courses that satisfy University United States/International Cultures requirement.
- W is the code used to designate courses that satisfy University Writing Across the Curriculum requirements.
- ~ indicates courses required to enter into this major.
- % indicates all 3 courses are required to graduate; a quality grade of C or better is required in 2 of the 3 courses.
- # any 400 level Biochemistry & Molecular Biology (BMB), Microbiology (MICRB), or Biotechnology (BIOTC) lecture course or Food Science (FD SC) 408. Spring - only taught courses: BMB 221, 252H, 402H, 433, 437, 445W, 474 BMB/MICRB 432, 460, 480 MICRB 201H, 412, 415, 422, 447% indicates all 3 courses are required to graduate; a quality grade of C or better is required in 2 of the 3 courses.

---

**Degree Requirements**

**Biotechnology - General Option**
Degree Requirements

- ± indicates see the Department List for exclusions see reverse side
- ^ indicates honor students should schedule ENGL/CAS 137H in the fall and ENGL/CAS 138T in the spring. The sequence should be completed in the first year.
- To graduate, all students must earn a C or higher in 9 credits of any 400-level BMB/MICRB/BIOTC courses except BMB 442, 443W, 445W, 448, 496, MICRB 421W, 422, 447

Scheduling patterns for courses not taught each semester
Fall - only taught courses: BMB 251H, 400, 401H, 428, 430, 443W, 448, 464 BMB/MICRB 435, 450 MICRB 401, 413, 421W and MICRB/BIOTC 416


± LIST C FREE ELECTIVES - With the EXCEPTION of the courses listed below, ALL courses appearing in the University Bulletin are acceptable as elective courses: 6 credits of ROTC may be applied toward graduation requirements.

Students MAY NOT fulfill this requirement with lower level or general education courses in math and science (including but not limited to examples such as: any BI SC course, any B M B course below the 100 level, MATH 110 and 111, and the like).

Students MAY NOT fulfill this requirement with courses that significantly repeat material from courses required for the major, (including but not limited to examples such as: CHEM 202 or 203 after taking CHEM 210 or 212, or vice-versa; PHYS 250 or 251 after taking PHYS 211, 212, 213, and 214, or vice-versa; and so forth).

Students MAY NOT fulfill this requirement with remedial courses (including but not limited to examples such as: LL ED 005 and 010; ENGL 004, 005, and 006; CHEM courses below CHEM 110; MATH courses below MATH 110; STAT 100; PHYS courses below PHYS 211; and the like).
The Bachelor of Science Degree in Biotechnology with the Clinical Laboratory Science Option

The Clinical Laboratory Science (CLS) option of the Biotechnology major is offered for students who enjoy laboratory work and who would consider a career as a scientist in the laboratory of a hospital or physician office laboratory. CLS positions typically call for certified individuals. To become certified, students need a B.S. degree and formal clinical education, and they must pass a national test to demonstrate understanding of the science they will practice. Thus, the CLS option requires a 10-month period of course work at an affiliated School of Clinical Laboratory Science. This is undertaken during the senior year after students have completed all basic science and general education courses of their undergraduate program. Current affiliations exist with Mt. Nittany Medical Center and with Pennsylvania Hospital in Philadelphia. Graduates enjoy outstanding job opportunities, in the clinical environment, as well as the industrial sector.

BIOTC CLS Option Check Sheet (125 credits)

1. GENERAL EDUCATION
   ARTS (6 cr)
   ______________________ (GA) 3 crs
   ______________________ (GA) 3 crs
   ______________________ (GA) 3 crs
   HUMANITIES (6 cr)
   ______________________ (GH) 3 crs
   ______________________ (GH) 3 crs
   ______________________ (GH) 3 crs
   SOCIAL & BEHAVIORAL SCIENCES (6 cr)
   ______________________ (GS) 3 crs
   ______________________ (GS) 3 crs
   ______________________ (GS) 3 crs

   Students may petition to substitute 3 credits from one of the above knowledge domains for 3 credits in another domain, thereby substituting 9-6-3 credit pattern for the default 6-6-6 pattern in these general education courses.

   COMMUNICATIONS (GWS) (9 cr)
   _______ ENGL 015 or 030: Rhetoric & Comp 3 crs
   _______ ENGL 202C: Technical Writing 3 crs
   _______ CAS 100 A, B or C: Effective Speech 3 crs

   HEALTH & PHYSICAL ACTIVITIES (3 cr)
   ______________________ (GHA or GHS or GPE) __ crs

   WRITING ACROSS the CURRICULUM (W) (3 cr)
   ______________________ (W) 3 crs

   US/INTERNATIONAL CULTURES (6 cr)
   ______________________ (US) 3 crs
   ______________________ (IL) 3 crs

   Total General Education Credits: ________
## Degree Requirements

### 2. REQUIREMENTS FOR THE MAJOR

#### CHEMISTRY (8 cr)
- **CHEM 110: (H): Chemical Principles I** 3
- **CHEM 111: Experimental Chemistry I** 1
- **CHEM 112: (H): Chemical Principles II** 3
- **CHEM 113: Experimental Chemistry II** 1

#### BIOCHEMISTRY & MOLECULAR BIOLOGY (6 cr)
- **BMB 211: Elementary Biochem** 3
- **BMB 212: Elementary Biochem Lab** 1
- **BMB 221: Applied Biochemistry** 2

#### MICROBIOLOGY (52 cr)
- **MICRB 201: Intro. Microbiology** 3
- **MICRB 202: Intro. Microbiology Lab** 2
- **MICRB 251: Molecular & Cell Biology I** 3
- **MICRB 252: Molecular & Cell Biology II** 3
- **MICRB 410: Principals of Immunology** 3
- **MICRB 412: Medical Microbiology** 3
- **MICRB 421W: Lab Gen/ Applied Micro** 3
- **MICRB 422: Medical Microbiology Lab** 2
- **MICRB 405 AF Seminar/Practicum** 30

#### MATHEMATICS (8 cr)
- **MATH 140: Calculus I** 4
- **MATH 141: Calculus II** 4

#### BIOLOGY (3 cr)
- **BIOL 322: Genetic Analysis** 3

#### PHYSICS (8 cr)
- **PHYS 250: Intro Physics I** 4
- **PHYS 251: Intro Physics II** 4

#### FIRST YEAR SEMINAR (1 cr)
- **PSU 016: First Year Seminar Science** 1

All of the above courses are **required** for the Biotechnology Major, Clinical Laboratory Science Option.

*Note: a “C” or better grade is required in CHEM 110, 111, 112, MATH 140 and at least 2 of the following MICRB 251, 252 or MICRB 201

Total Major Requirement Credits:__________
3. ELECTIVES IN THE MAJOR

Select 6 or 8 credits from chemistry sequence:

_____CHEM 210: (H): Organic Chemistry I 3
_____CHEM 212: (H): Organic Chemistry II 3
_____CHEM 213: Organic Chemistry Lab 2

Or

_____CHEM 202: Fund.of Organic Chem I 3
_____CHEM 203: Fund. of Organic Chem II 3

4. LIST C FREE ELECTIVES

Select 1-3 credits from Department List

__________ crs
__________ crs
__________ crs
__________ crs

LIST C FREE ELECTIVES - With the EXCEPTION of the courses listed below, ALL courses appearing in the University Bulletin are acceptable as elective courses: 6 credits of ROTC may be applied toward graduation requirements.

Students MAY NOT fulfill this requirement with lower level or general education courses in math and science (including but not limited to examples such as: any BI SC course, any B M B course below the 100 level, MATH 110 and 111, and the like).

Students MAY NOT fulfill this requirement with courses that significantly repeat material from courses required for the major, (including but not limited to examples such as: CHEM 202 or 203 after taking CHEM 210 or 212, or vice-versa; PHYS 250 or 251 after taking PHYS 211, 212, 213, and 214, or vice-versa; and so forth).

Students MAY NOT fulfill this requirement with remedial courses (including but not limited to examples such as: LL ED 005 and 010; ENGL 004, 005, and 006; CHEM courses below CHEM 110; MATH courses below MATH 110; STAT 100; PHYS courses below PHYS 211; and the like).

Total Free Elective Credits:__________

5. TO GRADUATE

A "C" grade or better is required in 2 of the following 3 courses. All 3 courses are required.

_____MICRB 201: Intro. Microbiology 3
_____MICRB 251: Molecular & Cell Biology I 3
_____MICRB 252: Molecular & Cell Biology II 3

Total ≥ 9

Earn "C" or Higher in 9 credits of any 400-level MICRB/BMB/BIOTC courses except BMB 442, 443W, 445W, 448, 488, 496, MICRB 421W, MICRB 422, MICRB 447
Degree Requirements

6. ENTRANCE TO MAJOR

A student enrolled in this major must receive a grade “C” or better in the following courses specified by Senate Policy 82-44

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 110(H): Chemical Principles I</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 111: Experimental Chemistry I</td>
<td>1</td>
</tr>
<tr>
<td>CHEM 112 (H): Chemical Principles II</td>
<td>3</td>
</tr>
<tr>
<td>MATH 140: Calculus I</td>
<td>4</td>
</tr>
</tbody>
</table>

2.0 GPA is required

7. REMEDIAL & REPEATS

Courses that do not meet degree requirements:

<table>
<thead>
<tr>
<th>crs</th>
<th>crs</th>
<th>crs</th>
<th>crs</th>
</tr>
</thead>
</table>

8. SENATE POLICY 8380

Source/Time Credit acquisition:

- 36 of last 60 credits at PSU? _______crs
- 60 credits in last 5 years? _______crs

9. GPA/CREDITS

Overall GPA must be ≥ 2.0: __________

Total Credits Earned (less repeats and remedial; must have at least 125 to graduate): _______

10. University Activities/Awards

11. Program Exceptions:
### Recommended Academic Plan

**Biotechnology Clinical Laboratory Science Option (BIOTC CLS at UP)**

**Effective (For students entering Fall 2012 and later)**

<table>
<thead>
<tr>
<th>Semester 1</th>
<th>Credits</th>
<th>Semester 2</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>MATH 140 (GQ) Calculus with Analytic Geometry I</td>
<td>4</td>
<td>MATH 141(GQ) Calculus with Analytic Geometry II</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 110 (GN) Chemical Principles</td>
<td>3</td>
<td>CHEM 112 (GN) Chemical Principles</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 111 (GN) Experimental Chemistry</td>
<td>1</td>
<td>CHEM 113 (GN) Experimental Chemistry</td>
<td>1</td>
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<tr>
<td>PSU 016 First-Year Seminar</td>
<td>1</td>
<td>% MICRB 201 Introductory Microbiology</td>
<td>3</td>
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<tr>
<td>Arts (GA), Humanities (GH) or Social Behavioral Sciences (GS)</td>
<td>3</td>
<td>MICRB 202 Introductory Microbiology Laboratory</td>
<td>2</td>
</tr>
<tr>
<td>^ ENGL 15 (30) Rhetoric and Composition (GWS)</td>
<td>3</td>
<td>^ CAS 100 A, B, or C (GWS) Effective Speech</td>
<td>3</td>
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<tr>
<td><strong>Total Credits:</strong></td>
<td>15</td>
<td><strong>Total Credits:</strong></td>
<td>16</td>
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<th>Semester 4</th>
<th>Credits</th>
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<tbody>
<tr>
<td>CHEM 202 (must be taken in sequence with CHEM 203) or CHEM 210 Organic Chemistry (must be taken in sequence with CHEM 212 &amp; 213)</td>
<td>3</td>
<td>CHEM 203 (must be taken in sequence with CHEM 202) or CHEM 212 Organic Chemistry (must be taken in sequence with CHEM 210 &amp; 212)</td>
<td>3</td>
</tr>
<tr>
<td>% MICRB 251 Molecular &amp; Cell Biology I</td>
<td>3</td>
<td>% MICRB 252 Molecular &amp; Cell Biology II</td>
<td>3</td>
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<tr>
<td>PHYS 250 (GN) Introduction Physics I</td>
<td>4</td>
<td>PHYS 251 (GN) Introductory Physics II</td>
<td>4</td>
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<tr>
<td>Arts (GA), Humanities (GH) or Social Behavioral Sciences (GS)</td>
<td>6</td>
<td>BIOL 322 Genetic Analysis</td>
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<td>Health &amp; Physical Activity (GHA)</td>
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<td>BMB 221 Applied Biochemistry</td>
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<td>BMB 212 Elementary Biochemistry Laboratory</td>
<td>1</td>
<td>MICRB 412 Medical Microbiology</td>
<td>3</td>
</tr>
<tr>
<td>MICRB 410 Principles of Immunology</td>
<td>3</td>
<td>MICRB 422 Medical Microbiology Laboratory</td>
<td>2</td>
</tr>
<tr>
<td>MICRB 421W Laboratory of General &amp; Applied Microbiology</td>
<td>3</td>
<td>ENGL 202C Technical Writing</td>
<td>3</td>
</tr>
<tr>
<td>Arts (GA), Humanities (GH) or Social Behavioral Sciences (GS)</td>
<td>6</td>
<td>± LIST C FREE ELECTIVES</td>
<td>1-3</td>
</tr>
<tr>
<td>Health &amp; Physical Activity (GHA)</td>
<td>1.5</td>
<td>Arts (GA), Humanities (GH) or Social Behavioral Sciences (GS)</td>
<td>3</td>
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<td><strong>Total Credits:</strong></td>
<td>17.5</td>
<td><strong>Total Credits:</strong></td>
<td>14-16</td>
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<th>Semester 7</th>
<th>Credits</th>
<th>Semester 8</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MICRB 405A Seminar &amp; Practicum in Medical Technology</td>
<td>8</td>
<td>MICRB 405D Seminar &amp; Practicum in Medical Technology</td>
<td>5</td>
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<tr>
<td>MICRB 405B Seminar &amp; Practicum in Medical Technology</td>
<td>1</td>
<td>MICRB 405E Seminar &amp; Practicum in Medical Technology</td>
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<tr>
<td>MICRB 405C Seminar &amp; Practicum in Medical Technology</td>
<td>6</td>
<td>MICRB 405F Seminar &amp; Practicum in Medical Technology</td>
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<tr>
<td><strong>Total Credits:</strong></td>
<td>15</td>
<td><strong>Total Credits:</strong></td>
<td>15</td>
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</tbody>
</table>

- **Bold** type indicates courses requiring a quality grade of C or better.
- **Italic** type indicates courses that satisfy both major and General Education requirements.
- **Italic Bold** type indicates courses requiring a quality grade of C or better and that satisfy both major and General Education requirements.
- GWS, GHA, GQ, GN, GA, GH, and GS are codes used to identify General Education requirements.
- US, IL, and US;IL are codes used to designate courses that satisfy University United States/International Cultures requirement.
- W is the code used to designate courses that satisfy University Writing Across the Curriculum requirements.
- ~ indicates courses required to enter into this major.
- % indicates all 3 courses are required to graduate; a quality grade of C or better is required in 2 of the 3 courses.
- ± indicates see the Department List for exclusions see reverse side.
- ^ indicates honor students should schedule ENGL/CAS 137H in the fall and ENGL/CAS 138T in the spring. The sequence should be completed in the first year.
- To graduate, all students must earn a C or higher in 9 credits of any 400-level BMB/ MICRB/BIOTC courses except BMB 442, 443W, 445W, 448, 488, 496, MICRB 421W, 422, 447

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**Biotechnology - Clinical Laboratory Science Option**
Scheduling patterns for courses not taught each semester

Fall - only taught courses: BMB 251H, 400, 401H, 428, 430, 443W, 448, 464 BMB/MICRB 435, 450 MICRB 401, 413, 421W and MICRB/BIOTC 416


± LIST C FREE ELECTIVES - With the EXCEPTION of the courses listed below, ALL courses appearing in the University Bulletin are acceptable as elective courses: 6 credits of ROTC may be applied toward graduation requirements.

Students MAY NOT fulfill this requirement with lower level or general education courses in math and science (including but not limited to examples such as: any BI SC course, any B M B course below the 100 level, MATH 110 and 111, and the like).

Students MAY NOT fulfill this requirement with courses that significantly repeat material from courses required for the major, (including but not limited to examples such as: CHEM 202 or 203 after taking CHEM 210 or 212, or vice-versa; PHYS 250 or 251 after taking PHYS 211, 212, 213, and 214, or vice-versa; and so forth).

Students MAY NOT fulfill this requirement with remedial courses (including but not limited to examples such as: LL ED 005 and 010; ENGL 004, 005, and 006; CHEM courses below CHEM 110; MATH courses below MATH 110; STAT 100; PHYS courses below PHYS 211; and the like).
The Bachelor of Science Degree in Microbiology (125 credits)

The Microbiology major is the major of choice for students interested in such fields as virology, immunology, and bacteriology. Whether it is tackling questions about the molecular biology of how a virus replicates inside a living cell, or how the body is able to defend itself against foreign agents, or how a bacterium controls its metabolism to live exclusively on the energy of inorganic compounds or in association with animal or human hosts in biofilms, it is the discipline of microbiology that focuses on such problems. The Micrb major requires 8-credits of physics, but otherwise shares the same basic science foundation with the BMB major. Some advanced courses in the major are viral pathogenesis, microbial diversity, tumor viruses and oncogenes, industrial, and food microbiology. Graduates are well-prepared for graduate and professional schools and for positions in the biopharmaceutical industry.

MICRB Check Sheet (125 credits)

1. GENERAL EDUCATION

   ARTS (6 cr)
   ______________________ (GA) 3 crs
   ______________________ (GA) 3 crs
   ______________________ (GA) 3 crs

   HUMANITIES (6 cr)
   ______________________ (GH) 3 crs
   ______________________ (GH) 3 crs
   ______________________ (GH) 3 crs

   SOCIAL & BEHAVIORAL SCIENCES (6 cr)
   ______________________ (GS) 3 crs
   ______________________ (GS) 3 crs
   ______________________ (GS) 3 crs

   Students may petition to substitute 3 credits from one of the above knowledge domains for 3 credits in another domain, thereby substituting 9-6-3 credit pattern for the default 6-6-6 pattern in these general education courses.

   COMMUNICATIONS (GWS) (9 cr)
   _______ ENGL 015 or 030: Rhetoric & Comp  3 crs
   _______ ENGL 202C: Technical Writing  3 crs
   _______ CAS 100 A, B or C: Effective Speech  3 crs

   HEALTH & PHYSICAL ACTIVITIES (3 cr)
   ______________________ (GHA or GHS or GPE) ___ crs
   ______________________ (GHA or GHS or GPE) ___ crs
   ______________________ (GHA or GHS or GPE) ___ crs

   WRITING ACROSS the CURRICULUM (W) (3cr)
   ______________________ (W)  3 crs

   US/INTERNATIONAL CULTURES (6 cr)
   ______________________ (US)  3 crs
   ______________________ (IL)  3 crs

   Total General Education Credits:__________
## Degree Requirements

### 2. REQUIREMENTS FOR THE MAJOR

#### CHEMISTRY (16 cr)
- *CHEM 110: (H): Chemical Principles I 3
- *CHEM 111: Experimental Chemistry I 1
- *CHEM 112: (H): Chemical Principles II 3
- CHEM 113: Experimental Chemistry II 1
- CHEM 210: (H): Organic Chemistry I 3
- CHEM 212: (H): Organic Chemistry II 3
- CHEM 213: Organic Chemistry Lab 2

#### MICROBIOLOGY (14 cr)
- *MICRB 201: Intro. Microbiology 3
- MICRB 202: Intro. Microbiology Lab 2
- *MICRB 251: Molecular & Cell Biology I 3
- *MICRB 252: Molecular & Cell Biology II 3
- MICRB 421W: Lab Gen/ Applied Micro 3

#### BIOCHEMISTRY & MOLECULAR BIOLOGY (14 cr)
- BMB 400: Molec. Biol. of the Gene 2
- BMB 401: General Biochemistry 3
- BMB 402: General Biochemistry 3
- BMB 428: Physical Chem w/Biological Apps 3
- BMB 442: Lab Prot., Nuc. Acid, Molec Clon 3

#### MATHEMATICS (8 cr)
- *MATH 140: Calculus I 4
- MATH 141: Calculus II 4

#### BIOLOGY (3 cr)
- BIOL 322: Genetic Analysis 3

#### PHYSICS (8 cr)
- PHYS 250: Intro Physics I 4
- PHYS 251: Intro Physics II 4

#### FIRST YEAR SEMINAR (1 cr)
- PSU 016: First Year Seminar Science 1

All of the above courses are required for the Microbiology Major.

*Note: a “C” or better grade is required in CHEM 110, 111, 112, MATH 140 and at least 2 of the following BMB 251, 252 or MICRB 201

Total Major Requirement Credits:__________
3. ELECTIVES IN THE MAJOR

a. Select any 4 of the following courses

- **MICRB 401**: Microb Physiology 3
- **MICRB 410**: Principals of Immunology 3
- **MICRB 412**: Medical Microbiology 3
- **MICRB 415**: General Virology 3
- **MICRB 450**: Micrb/Molec Genetics 2

b. Select 3 credits in 400-level laboratory courses

- **MICRB 422**: Medical Microbiology Lab 2
- **MICRB 447**: Molec Immunology Lab 1
- **BMB 445W**: Lab Molec Genetics I 2
- **BMB 448**: Model Systems & Approaches in Cell Biol. 2

+ 

c. Select 6-7 credits from FD SC 408(2), or any 400-level MICRB course with a total maximum of 4 credits in BMB 488 and/or BMB 496

Total Electives in the Major ≥ 21

4. LIST C FREE ELECTIVES

Select 9-11 credits from Department List

LIST C FREE ELECTIVES - With the EXCEPTION of the courses listed below, ALL courses appearing in the University Bulletin are acceptable as elective courses: 6 credits of ROTC may be applied toward graduation requirements.

Students MAY NOT fulfill this requirement with lower level or general education courses in math and science (including but not limited to examples such as: any BI SC course, any B M B course below the 100 level, MATH 110 and 111, and the like).

Students MAY NOT fulfill this requirement with courses that significantly repeat material from courses required for the major, (including but not limited to examples such as: CHEM 202 or 203 after taking CHEM 210 or 212, or vice-versa; PHYS 250 or 251 after taking PHYS 211, 212, 213, and 214, or vice-versa; and so forth).

Students MAY NOT fulfill this requirement with remedial courses (including but not limited to examples such as: LL ED 005 and 010; ENGL 004, 005, and 006; CHEM courses below CHEM 110; MATH courses below MATH 110; STAT 100; PHYS courses below PHYS 211; and the like).

Total Free Elective Credits:__________
## 5. TO GRADUATE

A "C" grade or better is required in **2** of the following **3** courses. **All 3 courses are required.**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MICRB 201: Intro. Microbiology</td>
<td>3</td>
</tr>
<tr>
<td>MICRB 251: Molecular &amp; Cell Biology I</td>
<td>3</td>
</tr>
<tr>
<td>MICRB 252: Molecular &amp; Cell Biology II</td>
<td>3</td>
</tr>
</tbody>
</table>

Total ≥ 9

+ Earn "C" or Higher in **9 credits** of any 400-level MICRB/BMB/BIOTC courses **except** BMB 442, 443W, 445W, 448, 488, 496, MICRB 421W, MICRB 422, MICRB 447

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total ≥ 9

## 6. ENTRANCE TO MAJOR

A student enrolled in this major must receive a grade "C" or better in the following courses specified by Senate Policy 82-44

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 110(H): Chemical Principles I</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 111: Experimental Chemistry I</td>
<td>1</td>
</tr>
<tr>
<td>CHEM 112 (H): Chemical Principles II</td>
<td>3</td>
</tr>
<tr>
<td>MATH 140: Calculus I</td>
<td>4</td>
</tr>
</tbody>
</table>

2.0 GPA is required

## 7. REMEDIAL & REPEATS

Courses that do not meet degree requirements:

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## 8. SENATE POLICY 8380

Source/Time Credit acquisition:
- 36 of last 60 credits at PSU? __________crs
- 60 credits in last 5 years? __________crs

## 9. GPA/CREDITS

Overall GPA must be ≥ 2.0: __________

Total Credits Earned (less repeats and remedial; must have at least 125 to graduate): __________

## 10. University Activities/Awards

## 11. Program Exceptions:
### Recommended Academic Plan
#### Microbiology (MICRB at UP)
##### Effective (For students entering Fall 2012)

<table>
<thead>
<tr>
<th>Semester 1</th>
<th>Credits</th>
<th>Semester 2</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>~ MATH 140 (GQ) Calculus with Analytic Geometry I</td>
<td>4</td>
<td>MATH 141(GQ) Calculus with Analytic Geometry II</td>
<td>4</td>
</tr>
<tr>
<td>~ CHEM 110 (GN) Chemical Principles</td>
<td>3</td>
<td>~ CHEM 112 (GN) Chemical Principles</td>
<td>3</td>
</tr>
<tr>
<td>~ CHEM 111 (GN) Experimental Chemistry</td>
<td>1</td>
<td>CHEM 113 (GN) Experimental Chemistry</td>
<td>1</td>
</tr>
<tr>
<td>PSU 016 First-Year Seminar</td>
<td>1</td>
<td>% MICRB 201 Introductory Microbiology</td>
<td>3</td>
</tr>
<tr>
<td>Arts (GA), Humanities (GH) or Social Behavioral Sciences (GS)</td>
<td>3</td>
<td>MICRB 202 Introductory Microbiology Laboratory</td>
<td>2</td>
</tr>
<tr>
<td>^ ENGL 15 (30) Rhetoric and Composition (GWS)</td>
<td>3</td>
<td>^ CAS 100 A, B, or C (GWS) Effective Speech</td>
<td>3</td>
</tr>
<tr>
<td>PSU 016 First-Year Seminar</td>
<td>1</td>
<td>% MICRB 201 Introductory Microbiology</td>
<td>3</td>
</tr>
<tr>
<td>Arts (GA), Humanities (GH) or Social Behavioral Sciences (GS)</td>
<td>3</td>
<td>MICRB 202 Introductory Microbiology Laboratory</td>
<td>2</td>
</tr>
<tr>
<td>^ ENGL 15 (30) Rhetoric and Composition (GWS)</td>
<td>3</td>
<td>^ CAS 100 A, B, or C (GWS) Effective Speech</td>
<td>3</td>
</tr>
<tr>
<td>Total Credits:</td>
<td>15</td>
<td>Total Credits:</td>
<td>16</td>
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<table>
<thead>
<tr>
<th>Semester 3</th>
<th>Credits</th>
<th>Semester 4</th>
<th>Credits</th>
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<tbody>
<tr>
<td>CHEM 210 Organic Chemistry</td>
<td>3</td>
<td>CHEM 212 Organic Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>% MICRB 251 Molecular &amp; Cell Biology I</td>
<td>3</td>
<td>CHEM 213 Laboratory in Organic Chemistry</td>
<td>2</td>
</tr>
<tr>
<td>PHYS 250 (GN) Introduction Physics I</td>
<td>4</td>
<td>PHYS 251 (GN) Introduction Physics II</td>
<td>4</td>
</tr>
<tr>
<td>± LIST C FREE ELECTIVE</td>
<td>3</td>
<td>% MICRB 252 Molecular &amp; Cell Biology II</td>
<td>3</td>
</tr>
<tr>
<td>Arts (GA), Humanities (GH) or Social Behavioral Sciences (GS)</td>
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<td>BIOL 322 Genetic Analysis</td>
<td>3</td>
</tr>
<tr>
<td>Total Credits:</td>
<td>16</td>
<td>Total Credits:</td>
<td>15</td>
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<table>
<thead>
<tr>
<th>Semester 5</th>
<th>Credits</th>
<th>Semester 6</th>
<th>Credits</th>
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<tbody>
<tr>
<td>BMB 400 Molecular Biology of the Gene</td>
<td>2</td>
<td>BMB 402 General Biochemistry</td>
<td>3</td>
</tr>
<tr>
<td>BMB 401 General Biochemistry</td>
<td>3</td>
<td>BMB 442 Laboratory in Proteins, Nucleic Acids, &amp; Molecular Cloning</td>
<td>3</td>
</tr>
<tr>
<td>* MICRB ELECT</td>
<td>3</td>
<td>* MICRB ELECT</td>
<td>3</td>
</tr>
<tr>
<td>MICRB 421W Laboratory of General &amp; Applied Microbiology</td>
<td>3</td>
<td># MICRB ELECT</td>
<td>2</td>
</tr>
<tr>
<td>Arts (GA), Humanities (GH) or Social Behavioral Sciences (GS)</td>
<td>3</td>
<td>Arts (GA), Humanities (GH) or Social Behavioral Sciences (GS)</td>
<td>3</td>
</tr>
<tr>
<td>Health &amp; Physical Activity (GHA)</td>
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<td>Health &amp; Physical Activity (GHA)</td>
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<table>
<thead>
<tr>
<th>Semester 7</th>
<th>Credits</th>
<th>Semester 8</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>* MICRB ELECT</td>
<td>3</td>
<td>@ MICRB ELECT</td>
<td>2-3</td>
</tr>
<tr>
<td># MICRB ELECT</td>
<td>1</td>
<td>* MICRB ELECT</td>
<td>2-3</td>
</tr>
<tr>
<td>@ MICRB ELECT</td>
<td>3-4</td>
<td>ENGL 202C (GWS) Technical Writing</td>
<td>3</td>
</tr>
<tr>
<td>BMB 428 Physical Chemistry with Biological Applications</td>
<td>3</td>
<td>Arts (GA), Humanities (GH) or Social Behavioral Sciences (GS)</td>
<td>3</td>
</tr>
<tr>
<td>± LIST C FREE ELECTIVES</td>
<td>3</td>
<td>± LIST C FREE ELECTIVES</td>
<td>2-3</td>
</tr>
<tr>
<td>Arts (GA), Humanities (GH) or Social Behavioral Sciences (GS)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Total Credits:</td>
<td>16-17</td>
<td>Total Credits:</td>
<td>12-15</td>
</tr>
</tbody>
</table>

- **Bold** type indicates courses requiring a quality grade of C or better.
- **Italic** type indicates courses that satisfy both major and General Education requirements.
- **Italic Bold** type indicates courses requiring a quality grade of C or better and that satisfy both major and General Education requirements.
- GWS, GHA, GN, GA, GH, and GS are codes used to identify General Education requirements.
- US, IL, and US;IL are codes used to designate courses that satisfy University United States/International Cultures requirement.
- W is the code used to designate courses that satisfy University Writing Across the Curriculum requirements.
- * indicates courses required to enter into this major.
- % indicates all 3 courses are required to graduate; a quality grade of C or better is required in 2 of the 3 courses.
- * indicates select 4 courses from: MICRB 401 (3), 410 (3), 412 (3), 415 (3), 450 (2)
- # indicates select 3 credits from: MICRB 422 (2), 447 (1), 445W (2), 448 (2)
- @ indicates select 6-7 credits from: FD SC 408 (2), B M B 488, B M B 496 or any MICRB 400-level course, with a total maximum of 4-credits in BMB 488 and/or 496.
- ± indicates see the Department List C for exclusions see reverse side
- ^ indicates honor students should schedule ENGL/CAS 137H in the fall and ENGL/CAS 138T in the spring. The sequence should be completed in the first year.
- To graduate, all students must earn a C or higher in 9 credits of any 400-level BMB/MICRB courses except BMB 442, 443W, 445W, 448, 488, 496, MICRB 421W, 422, 447

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Microbiology
Scheduling patterns for courses not taught each semester
Fall - only taught courses: BMB 251H, 400, 401H, 428, 430, 443W, 448, 464 BMB/MICRB 435, 450 MICRB 401, 413, 421W and MICRB/BIOTC 416


± LIST C FREE ELECTIVES - With the EXCEPTION of the courses listed below, ALL courses appearing in the University Bulletin are acceptable as elective courses: 6 credits of ROTC may be applied toward graduation requirements.

Students MAY NOT fulfill this requirement with lower level or general education courses in math and science (including but not limited to examples such as: any BI SC course, any B M B course below the 100 level, MATH 110 and 111, and the like).

Students MAY NOT fulfill this requirement with courses that significantly repeat material from courses required for the major, (including but not limited to examples such as: CHEM 202 or 203 after taking CHEM 210 or 212, or vice-versa; PHYS 250 or 251 after taking PHYS 211, 212, 213, and 214, or vice-versa; and so forth).

Students MAY NOT fulfill this requirement with remedial courses (including but not limited to examples such as: LL ED 005 and 010; ENGL 004, 005, and 006; CHEM courses below CHEM 110; MATH courses below MATH 110; STAT 100; PHYS courses below PHYS 211; and the like).
Student Organizations

The Biochemistry Society
In its promotional flier, the Biochemistry Society states the following:

If you are looking for other students interested in biochemistry/molecular biology, a study partner for one of your classes, or advice from more experienced students, then the Biochemistry Society of Penn State is for you! You will meet all varieties of people - pre-med students, research lovers, and double majors, just to list a few. Learn about the different things you can do with your major and all the opportunities available at Penn State. In addition to the vast array of experiences represented among our members, you can gain new perspectives by participation in seminars and listening to our guest speakers.

Meeting times and places are announced via the BMB list server, in the lobbies of Frear and Althouse buildings, in The Daily Collegian and on the Biochemistry Society's web page at http://bmb.psu.edu/undergraduate/student-organizations/biochemistrysociety

Student Chapter of the American Society for Microbiology
According to its own promotional flier, the Student Chapter of the American Society for Microbiology exists for at least three purposes:

1. to serve as a resource for current and prospective microbiology majors
   - answer questions on course selection, research, our major, etc.
   - participate in Eberly College of Science open houses and give tours to prospective students
   - provide information about graduate school and other career options

2. to provide a forum for socializing
   - get to know other microbiology majors at club meetings
   - participate in social and charitable events
   - get to meet and know more about undergraduate instructors
   - take exciting trips to the ASM branch meetings

3. promote public awareness of relevant microbiological topics

Meeting times are announced on the club bulletin board in South Frear. Visit the club's web page at: http://bmb.psu.edu/undergraduate/student-organizations/american-society-of-microbiology

The Biotech Club
Is for students interested in biotechnology. The Biotech Club acts as a bridge between students and biotech companies, and keeps members abreast of the latest biotech news. But we're all about fun too! It's the art of balance. To find out more about this club go to: http://bmb.psu.edu/undergraduate/student-organizations/biotech-club
Research & Scholarships

Research Opportunities in the Department of Biochemistry & Molecular Biology

B M B 496: Independent Research
As a university, Penn State has a vigorous and extensive research enterprise. Faculty are awarded grants by government and private agencies to conduct research in the many academic disciplines within the university structure. Undergraduates who qualify are invited to participate in the on-going research programs of BMB faculty. Typically, between 70 and 80 students are engaged in undergraduate research during the fall and spring semesters. Most of these students are juniors and seniors. Participation in undergraduate research requires an application be submitted which will be reviewed by faculty members selected by the student. Here’s how to arrange for a 496 position: [http://bmb.psu.edu/undergraduate/arranging-independent-research-in-bmb](http://bmb.psu.edu/undergraduate/arranging-independent-research-in-bmb)

B M B 488: Communities of Practice
(2 per semester/maximum of 16) This course combines laboratory research in a community of practice and a seminar on topics in science, ethics, and society. MICRB 201 & 202 are prerequisites for the course.

- Section 001: Antibiotics: Development and Resistance
Is a new experimental course that integrates primary research in antibiotic discovery with a student-driven seminar investigating scientific, societal, and ethical issues associated with antibiotic development and the spread of antibiotic resistance. Participation in section 001 of B M B 488 is application-based. Applications are taken the start of every semester. Detailed course information is available at: [http://bmb.psu.edu/undergraduate/courses/section-001-bmb-488](http://bmb.psu.edu/undergraduate/courses/section-001-bmb-488)

- Section 002: Genetic Control of Organogenesis
The goal of section 002 of B M B 488 is to provide authentic research experiences to students who are entering the major and to engage students in a community of practice, a group of scientists with varying levels of experience working toward a shared scientific objective. The scientific objective is to identify genes that direct morphogenesis of biological tubes by using RNAi and DIC microscopy to screen a selection of candidate genes for those with defects in morphogenesis of the *C. elegans vulva*. Students interested in section 002 should contact Dr. Wendy Hanna-Rose. Detailed course information can be found here: [http://bmb.psu.edu/undergraduate/courses/section-002-bmb-488](http://bmb.psu.edu/undergraduate/courses/section-002-bmb-488)

Scholarships in the Department of Biochemistry & Molecular Biology
The BMB department awards about ten department scholarships to its undergraduate students each year. In addition, the Eberly College of Science has a number of awards that circulate to designated departments within the college. Typically, BMB has about six of these awards to confer on a yearly basis. Students should think of these as awards, rather than scholarships, as the monies for each award come from the proceeds of endowments established by donors and, in many cases, carry restrictions for potential recipients (particular major, class standing, financial need, etc.). There is no application process. Rather, a department committee reviews all students who qualify for the various awards. Award recipients are generally selected at the end of each spring semester and are notified of their selection sometime during the summer months.

The BMB department currently has three to four awards that are designated for the support of students who are undertaking research in the BMB department during the summer. These awards are highly competitive, and there is an application process.

Applicants must be in one of the three majors in the department (BMB, MICRB, BIOTC). The applicants research adviser must nominate the applicant and provide a letter of support addressing: creativity, initiative, technical skills, ability to work independently. The applications are reviewed for the following criteria: 1) Quality of the description of the hypothesis to be tested 2) Recommendation of the adviser in terms of research aptitude and potential for success 3) Impact of the research experience on the future goals of the student 4) Length of previous research experience and 5) GPA
Penn State Learning
Penn State Learning provides a trained staff of peer tutors, an encouraging learning environment, and technology tools to enhance your academic success. A staff of over 100 peer tutors provide free out-of-class assistance through three campus locations: 220 Boucke Building, 7 Sparks Building, and 101A Leisure Reading Room in the Pattee Library. The learning centers provide free peer tutoring for individual and group work, access to reserve course materials, and a variety of technology. The centers feature digital video-editing equipment, access to the Penn State backbone, video and audio tape players, and more. For detailed information on their service, please visit http://pennstatelearning.psu.edu/

Office for Disability Services
At every Penn State location, there is an office designated to provide services for students with disabilities. Each designated office requests and maintains disability-related documents; certifies eligibility for services; determines academic adjustments, auxiliary aids, and/or services; and develops plans for the provision of academic adjustments, auxiliary aids, and/or services as mandated under Title II of the Americans with Disabilities Act (ADA) of 1990 and Section 504 of the Rehabilitation Act of 1973.

The Office for Disability Services (ODS) is the designated office that provides services to students with disabilities who are enrolled at the University Park location. At other Penn State locations, services are provided through the Disability Contact Liaisons. A list of the Disability Contact Liaisons (DCL) at other Penn State locations can be found at the following link: http://equity.psu.edu/ods.

To contact the Disability Service Office at University Park:

The Office for Disability Services
The Pennsylvania State University
116 Boucke Building
University Park, PA 16802-5902
Phone: 814-863-1807 (V/TTY)
Fax: 814-863-3217
Climate & Diversity

"Climate" & Diversity within the Department of Biochemistry and Molecular Biology

A central goal of the biochemistry and molecular biology department is to establish a welcoming environment in which all students, researchers, faculty, and staff can contribute fully in the shared mission of education, research, and service. Doing so requires a climate in which the diversity of our membership in terms of racial and cultural heritage, gender, physical ability, sexual orientation, and educational background is both recognized and appreciated. It requires a climate in which individuals are intrinsically valued and respected, irrespective of such differences, and where everyone is encouraged to achieve his/her maximum potential.

The Biochemistry and Molecular Biology Department Climate & Diversity Committee

The Biochemistry and Molecular Biology Department Climate & Diversity Committee was instituted in 2002 at the request of Dean Larson. The purpose of this committee is to continuously monitor the climate within the department, to serve as a contact point for persons seeking help with workplace relationships, to maintain communications around different groups within the department among different groups within the department, and to provide suggestions for ways to achieve the goals set forth above.

Current members of the committee can be found at: http://bmb.psu.edu/about-us/climate-and-diversity

The committee members welcome input concerning general issues related to improving the environment of the BMB department as a place to work and study. Contact anyone of the members and he/she will bring comments and suggestions to the committee for discussion.

In addition, feel free to contact individual committee members to discuss personal concerns related to workplace climate/interaction issues. Any such contacts will be kept strictly confidential.

Sexual Harassment

Sexual harassment by faculty, staff, or students will not be tolerated at Penn State. The University takes an active role in providing information and/or training to students and employees on the seriousness of such behavior and the importance of ensuring an educational work environment in which all individuals are respected.

Any member of the University community who experiences sexual harassment should bring this problem to the attention of appropriate individuals. Sexual harassment complaints, you can contact the Campus Life Assistance Center (863-1809), the Affirmative Action Office (863-0471), or the Office of Human Resources (865-1412).