

MICROBIOLOGY, PHD

The Department of Bacteriology in the College of Agricultural and Life Sciences and the Department of Medical Microbiology and Immunology in the School of Medicine and Public Health (see separate course listings) administer the interdepartmental microbiology doctoral training program (MDTP). Incoming students have the opportunity to do laboratory rotations with any of the primary faculty, affiliate faculty, and trainers from multiple departments. This group includes more than 90 faculty members in numerous departments and programs involved in microbiology research and graduate training. In addition to this breadth of opportunities in microbiology research training, the program also encompasses graduate courses offered by both departments. Please refer to the separate Microbiology listing in this catalog for more detailed information, or visit the program website.

The PhD program prepares graduates for research and teaching positions in universities and colleges, for industry or government, and for clinical microbiology. Research emphasis includes, but is not limited to, prokaryotic (bacteria and archaea), viral and lower eukaryotic systems (fungi, oomycetes, and parasites); antibiotics and antibiotic resistance, biofilm formation; bioinformatics and computational biology; biotechnology and industrial microbiology, including biofuels; cell–cell signaling; cell motility and chemotaxis; DNA, including nucleic acid synthesis, DNA replication and recombination; food microbiology; fungal development, pathogenesis, and metabolism; gene expression and its regulation; immunology; microbial physiology and metabolism; macrophage activation and other cell immune systems; mechanisms of microbial persistence; mechanisms of pathogenesis; microbial cell division; microbial ecology; microbial microbiota and metagenomics; nitrogen fixation; quorum sensing; RNA, including molecular structure–function relationships of transfer RNA, small RNAs, RNA polymerase, and other components of transcription and translation; secondary metabolism; structural microbiology; symbioses, including host–microbe symbioses, plant–microbial interactions, animal–microbial interactions, microbe–microbe interactions; and virology, including host–virus interactions. Dissertation research emphasizes creative and innovative problem-solving using basic knowledge acquired through scientific interactions and collaborations in addition to a thorough understanding of the scientific literature.

In order to better train MDTP students for microbiology-related professions, students need a chance to gain knowledge and experience not just in academic research, but also in other fields where their microbiology education may be put to good use.

The professional development options encompass many professional development opportunities for MDTP students beyond academic research and teaching. Opportunities for professional development can consist of course work, an internship, a summer workshop, outreach experiences, or a second teaching–practicum experience.

DOUBLE DEGREE

Students may complete a double PhD degree in MDTP and another program on campus under the following conditions. The student must apply for admission to MDTP by the program's yearly deadline and be admitted using the same criteria applied to other applicants. The student must complete all requirements of the MDTP in addition to the requirements for the other program sponsoring the double degree. The student must pass a different preliminary examination in each program. The student's dissertation committee and preliminary examination must

adhere to MDTP guidelines. The PhD advisor must be a trainer in the MDTP. A significant portion of the student's dissertation research must be completed in the laboratory of the PhD advisor. The student's program, including any deviations, must be approved by the steering committee.

ADMISSIONS

ADMISSIONS

Please consult the table below for key information about this degree program's admissions requirements. The program may have more detailed admissions requirements, which can be found below the table or on the program's website.

Graduate admissions is a two-step process between academic programs and the Graduate School. **Applicants must meet the minimum requirements (<https://grad.wisc.edu/apply/requirements/>) of the Graduate School as well as the program(s).** Once you have researched the graduate program(s) you are interested in, apply online (<https://grad.wisc.edu/apply/>).

Requirements	Detail
Fall Deadline	December 1
Spring Deadline	The program does not admit in the spring.
Summer Deadline	The program does not admit in the summer.
GRE (Graduate Record Examinations)	Not required.
English Proficiency Test	Refer to the Graduate School: Minimum Requirements for Admission policy: https://policy.wisc.edu/library/UW-1241 (https://policy.wisc.edu/library/UW-1241/).
Other Test(s) (e.g., GMAT, MCAT)	n/a
Letters of Recommendation Required	3

PROGRAM APPLICATION MATERIALS

Note that all application materials are submitted through the UW Graduate School Admissions Office. (<https://grad.wisc.edu/apply/>) See the Microbiology program website (<https://microbiology.wisc.edu/how-to-apply/>) for more information and guidance for the application components.

- Personal statement, also known as "Statement of Purpose".
- An applicant background statement describing how the applicant's background and life experiences have motivated their decision to pursue a graduate degree at the University of Wisconsin.
- An unofficial copy of transcripts from each college or university attended.
- Three or more letters of reference from individuals (faculty, staff, supervisor, mentor) who can comment on the applicant's qualifications. This should include scholarly and academic qualifications, and can also include experiences in teaching, outreach, and community service. Directions for submission will be provided once you have initiated your application.

- A brief resume/CV listing academic awards, scholarships, location and length of research experiences, co-authorship on any publications or presentations at scientific conferences.

This program is a research-intensive program. Therefore, strong letters of recommendation, a well-crafted personal statement, and extensive research experience often aid applicants with below-average grades.

COURSE PREREQUISITES

We have recommended courses based on material that previous students have found valuable for success in the program, both in the lab and in required graduate level coursework. However, we recognize that the backgrounds of many students – and future student career goals – are varied and diverse, and that this diversity is a strength of our program. In the online application process, you will be asked if you have completed the following prerequisites:

Code	Title	Credits
Biology		
Students are recommended to have two semesters of biology, such as the following UW-Madison course equivalents.		
BIOLOGY/BOTANY/ ZOOLOGY 151 & BIOLOGY/ BOTANY/ ZOOLOGY 152	Introductory Biology and Introductory Biology	10
BIOLOGY/ ZOOLOGY 101 & BIOLOGY/ ZOOLOGY 102 & BIOLOGY/ BOTANY 130	Animal Biology and Animal Biology Laboratory and General Botany	10
Genetics		
Students are recommended to have one semester of genetics, such as the following UW-Madison course equivalents.		
MICROBIO 470	Microbial Genetics & Molecular Machines	3
GENETICS 466	Principles of Genetics	3
GENETICS 467 & GENETICS 468	General Genetics I and General Genetics 2	6
Chemistry		
Students are recommended to have four semesters of chemistry, including two semesters of organic chemistry with one semester organic chemistry lab component, such as the following UW-Madison course equivalents.		
CHEM 103 & CHEM 104	General Chemistry I and General Chemistry II	9
CHEM 109	Advanced General Chemistry	5
CHEM 115 & CHEM 116	Chemical Principles I and Chemical Principles II	10
CHEM 343 & CHEM 344 & CHEM 345	Organic Chemistry I and Introductory Organic Chemistry Laboratory and Organic Chemistry II	8
Biochemistry		

Students are recommended to have one semester of biochemistry, such as the following UW-Madison course equivalents.

BIOCHEM 501	Introduction to Biochemistry	3
BIOCHEM 507 & BIOCHEM 508	General Biochemistry I and General Biochemistry II	6-7

Physics

Students are recommended to have one semester of physics, such as the following UW-Madison course equivalents.

PHYSICS 104	General Physics	4
PHYSICS 202	General Physics	5
PHYSICS 208	General Physics	5

Mathematics

Students are recommended to have two semesters of calculus or one semester each of calculus and statistics, such as the following UW-Madison course equivalents.

MATH 171	Calculus with Algebra and Trigonometry I	5
MATH 217	Calculus with Algebra and Trigonometry II	5
MATH 221	Calculus and Analytic Geometry 1	5
STAT 301	Introduction to Statistical Methods	3
STAT 371	Introductory Applied Statistics for the Life Sciences	3

Physics (second semester) or Other Quantitative Reasoning

Students are recommended to have a second semester of physics or other quantitative reasoning course such as physical chemistry, differential equations, or upper-level course in computer programming, bioinformatics or statistics, such as the following UW-Madison course equivalents.

PHYSICS 104	General Physics	4
PHYSICS 202	General Physics	5
PHYSICS 208	General Physics	5
CHEM 561	Physical Chemistry I	3
CHEM 563 & CHEM 665	Physical Chemistry Laboratory I and Biophysical Chemistry	4
MICROBIO 657	Bioinformatics for Microbiologists	3
COMP SCI 319	Data Science Programming I for Research	3
COMP SCI/ B M I 576	Introduction to Bioinformatics	3
STAT 303	R for Statistics I	1
MATH 319	Techniques in Ordinary Differential Equations	3
MATH 320	Linear Algebra and Differential Equations	3

For each prerequisite, please be prepared to enter the course name and number. If you do not have all the recommended coursework, please use the text box in the application system to explain any deficiencies.

We ask that you fill in the course list as appropriate, but more broadly that you include a dedicated section within your personal statement to

note how your academic preparation has prepared you for PhD training in microbiology.

FUNDING

FUNDING

GRADUATE SCHOOL RESOURCES

The Bursar's Office provides information about tuition and fees associated with being a graduate student. Resources to help you afford graduate study might include assistantships, fellowships, traineeships, and financial aid. Further funding information is available from the Graduate School. Be sure to check with your program for individual policies and restrictions related to funding.

PROGRAM RESOURCES

Research assistantships are available for most students from department and college-level funding sources or from competitive fellowship and traineeship awards, with continued support contingent upon adequate progress in classes and research. Applicants with outstanding records will be nominated for special fellowships or for traineeships on one of several NIH training grants awarded to UW-Madison.

REQUIREMENTS

MINIMUM GRADUATE SCHOOL REQUIREMENTS

Review the Graduate School minimum degree requirements (<https://guide.wisc.edu/graduate/#requirementstext>) and policies (<https://guide.wisc.edu/graduate/#policiestext>), in addition to the program requirements listed below.

MAJOR REQUIREMENTS

MODE OF INSTRUCTION

Face to Face	Evening/ Weekend	Online	Hybrid	Accelerated
Yes	No	No	No	No

Mode of Instruction Definitions

Accelerated: Accelerated programs are offered at a fast pace that condenses the time to completion. Students typically take enough credits aimed at completing the program in a year or two.

Evening/Weekend: Courses meet on the UW-Madison campus only in evenings and/or on weekends to accommodate typical business schedules. Students have the advantages of face-to-face courses with the flexibility to keep work and other life commitments.

Face-to-Face: Courses typically meet during weekdays on the UW-Madison Campus.

Hybrid: These programs combine face-to-face and online learning formats. Contact the program for more specific information.

Online: These programs are offered 100% online. Some programs may require an on-campus orientation or residency experience, but the courses will be facilitated in an online format.

CURRICULAR REQUIREMENTS

Requirement Detail	
Minimum Credit Requirement	51 credits
Minimum Residence Credit Requirement	32 credits
Minimum Graduate Coursework Requirement	26 credits must be graduate-level coursework. Refer to the Graduate School: Minimum Graduate Coursework (50%) Requirement policy: https://policy.wisc.edu/library/UW-1244 (https://policy.wisc.edu/library/UW-1244/).
Overall Graduate GPA Requirement	3.00 GPA required. Refer to the Graduate School: Grade Point Average (GPA) Requirement policy: https://policy.wisc.edu/library/UW-1203 (https://policy.wisc.edu/library/UW-1203/).
Other Grade Requirements	n/a
Assessments and Examinations	Doctoral students are required to take a comprehensive preliminary/oral examination after they have cleared their record of all Incomplete and Progress grades (other than research and thesis). Deposit of the doctoral dissertation in the Graduate School is required.
Language Requirements	n/a
Graduate School Breadth Requirement	All doctoral students are required to complete a doctoral minor or graduate/professional certificate. Refer to the Graduate School: Breadth Requirement in Doctoral Training policy: https://policy.wisc.edu/library/UW-1200 (https://policy.wisc.edu/library/UW-1200/).

REQUIRED COURSES

Code	Title	Credits
Topics		
Students must complete the following courses.		
MICROBIO 810	Current Issues in Microbiology	1
MICROBIO 811	Advanced Problems in Microbiology	1
Electives		
Students must complete at least 9 credits or three courses from the following list.		9
GENETICS/ BIOCHEM/ MD GENET 620	Eukaryotic Molecular Biology	
GENETICS 885	Advanced Genomic and Proteomic Analysis	
MICROBIO 526	Physiology of Microorganisms	
MICROBIO/ BIOCHEM/ GENETICS 612	Prokaryotic Molecular Biology	
MICROBIO 626	Microbial and Cellular Metabolomics	
MICROBIO 657	Bioinformatics for Microbiologists	
MICROBIO/ BMOLCHEM 668	Microbiology at Atomic Resolution	
MICROBIO 710	Microbial Symbiosis	
M M & I/PATH- BIO 528	Immunology	

M M & I 740	Mechanisms of Microbial Pathogenesis
M M & I/PATH-BIO 750	Host-Parasite Relationships in Vertebrate Viral Disease
M M & I 760	Quantitative Systems Biology and Disease
ONCOLOGY/ M M & I/ PL PATH 640	General Virology-Multiplication of Viruses
PL PATH/ BOTANY/ GENETICS/ M M & I 655	Biology and Genetics of Fungi

Seminar

Students must complete 6 credits of seminar from one of the following courses. Students enroll for the program's seminar course during their first three years and must present during the third and fourth year of program. 6

MICROBIO 731 Seminar
or M M & I 901 Seminar

Breadth

Students take at least 10 credits in either an external or distributed doctoral minor or a graduate/professional certificate. 10

Additional Coursework

Students complete enough credits of additional coursework as well as 990 research credits to meet the 51-credit degree requirement. 24-26

Research Credits

Credits of 990 in subjects outside of MICROBIO and M M I are acceptable with advisor approval.

M M & I 990 Research and Thesis
or MICROBIO 990 Research

Coursework Credits

Courses are chosen in consultation with the thesis committee.

Total Credits 51

Rotation Requirement

Incoming students are required to rotate in a minimum of three research labs. Students who are directly admitted into a lab are exempt from this rotation requirement.

Teaching Practicum Requirement

All students in the program are required to complete a teaching practicum.

This is usually completed during the second year. Students choose from a list of courses and work with faculty delivering instruction in a lecture or lab setting.

Professional Development Requirement

Professional development is a required part of the program's curriculum. Students must receive approval from their thesis committee on the activity chosen to satisfy this requirement. Thesis committees will also determine if each student has met the requirement. Students should complete the professional development requirement by the end of the fourth year.

This requirement is fulfilled by:

- completing a second semester of teaching practicum,
- carrying out an internship for as long as one semester,
- taking at least 2 credits of coursework from the list of approved classes or through the Delta Program, or
- performing other professional development activities equivalent to 2 semester hours of coursework as judged by the thesis committee.

Professional Development Activities Courses

The Graduate School has agreed to allow dissertator students to enroll in courses from a limited list of classes appropriate for professional development of the program's students. Students would take one or two courses in an area of interest after they become dissertators. Additional courses may be added to this list if they are appropriate for the program's students and are approved for this purpose by the Graduate School.

Teaching Practicum

A second semester of teaching practicum may be the most appropriate training for students that seek a career in academic research and teaching. If students do not arrange for other professional development activities, the default professional development training would be a second semester of teaching in a teaching practicum.

The Delta Program

Students interested in teaching as a career can complete the Higher Education Teaching and Learning (<https://guide.wisc.edu/graduate/graduate-school-wide/higher-education-teaching-learning-graduate-professional-certificate/>) graduate/professional certificate through the Delta Program. Completing this certificate prepares students to become a leaders in teaching and learning, promoting inclusive and effective educational experiences at the college level. Through this program, students gain the skills and confidence needed to thrive as an instructor and mentor, be competitive for faculty positions and other academic roles, and contribute to the advancement of teaching and learning practices in their discipline.

Summer Courses or Workshops

For students most interested in continuing in academic research, one or more summer courses or workshops may be the most appropriate training. Examples of such courses are those that cover research areas or methods or scientific writing or grant preparation.

Internship

As an alternative to class work or a second semester of teaching practicum, students could participate in an internship with a business or other organization. Students doing internships would have to arrange to be paid through the organization, and they would not be paid by their advisors while away from their research.

POLICIES**GRADUATE SCHOOL POLICIES**

The Graduate School's Academic Policies and Procedures (<https://grad.wisc.edu/acadpolicy/>) serve as the official document of record for Graduate School academic and administrative policies and procedures and are updated continuously. Note some policies redirect to entries in the official UW-Madison Policy Library (<https://policy.wisc.edu/>). Programs may set more stringent policies than the Graduate School. Policies set by the academic degree program can be found below.

MAJOR-SPECIFIC POLICIES

PRIOR COURSEWORK

Graduate Credits Earned at Other Institutions

With program approval, up to 9 credits of coursework may be accepted from other graduate institutions. Coursework earned ten or more years prior to admission to a doctoral degree is not allowed to satisfy requirements.

Undergraduate Credits Earned at Other Institutions or UW-Madison

For well-prepared advanced students, the program may decide to accept up to 6 credits numbered 300 or above completed at UW-Madison toward fulfillment of minimum graduate degree credit requirements. This work would not be allowed to count toward the 50% graduate coursework minimum unless taken in coursework numbered 700 or above. Coursework earned ten or more years prior to admission to a doctoral degree is not allowed to satisfy requirements. Undergraduate credits earned at institutions other than UW-Madison may not count toward program degree requirements.

Credits Earned as a Professional Student at UW-Madison (Law, Medicine, Pharmacy, and Veterinary careers)

Refer to the Graduate School: Transfer Credits for Prior Coursework (<https://policy.wisc.edu/library/UW-1216/>) policy.

Credits Earned as a University Special student at UW-Madison

The program may decide to accept up to 9 University Special student credits toward fulfillment of the minimum graduate degree credit requirement. UW-Madison coursework taken as a University Special student would not be allowed to count toward the 50% graduate coursework minimum unless taken in coursework numbered 700 or above or are taken to meet the requirements of a capstone certificate and has the "Grad 50%" attribute. Coursework earned ten or more years prior to admission to a doctoral degree is not allowed to satisfy requirements.

PROBATION

Refer to the Graduate School: Probation (<https://policy.wisc.edu/library/UW-1217/>) policy.

ADVISOR / COMMITTEE

Refer to the Graduate School: Advisor (<https://policy.wisc.edu/library/UW-1232/>) and Graduate School: Committees (Doctoral/Master's/MFA) (<https://policy.wisc.edu/library/UW-1201/>) policies. Exceptions follow:

To ensure that students are making satisfactory progress toward a degree, students are required to meet with their advisor annually.

The committee is required to have five faculty members, two of which must hold appointments in either Bacteriology or Medical Microbiology and Immunology.

CREDITS PER TERM ALLOWED

15 credit maximum. Refer to the Graduate School: Maximum Credit Loads and Overload Requests (<https://policy.wisc.edu/library/UW-1228/>) policy.

TIME LIMITS

Refer to the Graduate School: Time Limits (<https://policy.wisc.edu/library/UW-1221/>) policy.

GRIEVANCES AND APPEALS

These resources may be helpful in addressing your concerns:

- Bias or Hate Reporting (<https://doso.students.wisc.edu/bias-or-hate-reporting/>)
- Graduate Assistantship Policies and Procedures (<https://hr.wisc.edu/policies/gapp/#grievance-procedure>)
- Hostile and Intimidating Behavior Policies and Procedures (<https://hr.wisc.edu/hib/>)
 - Office of the Provost for Faculty and Staff Affairs (<https://facstaff.provost.wisc.edu/>)
- Employee Assistance (<http://www.eao.wisc.edu/>) (for personal counseling and workplace consultation around communication and conflict involving graduate assistants and other employees, post-doctoral students, faculty and staff)
- Employee Disability Resource Office (<https://employeedisabilities.wisc.edu/>) (for qualified employees or applicants with disabilities to have equal employment opportunities)
- Graduate School (<https://grad.wisc.edu/>) (for informal advice at any level of review and for official appeals of program/departmental or school/college grievance decisions)
- Office of Compliance (<https://compliance.wisc.edu/>) (for class harassment and discrimination, including sexual harassment and sexual violence)
- Office Student Assistance and Support (OSAS) (<https://osas.wisc.edu/>) (for all students to seek grievance assistance and support)
- Office of Student Conduct and Community Standards (<https://conduct.students.wisc.edu/>) (for conflicts involving students)
- Ombuds Office for Faculty and Staff (<http://www.ombuds.wisc.edu/>) (for employed graduate students and post-docs, as well as faculty and staff)
- Title IX (<https://compliance.wisc.edu/titleix/>) (for concerns about discrimination)

The program will follow the College of Agricultural and Life Sciences Grievance Policy. For clarity, the program director, vice-director and/or the program coordinator shall serve as grievance advisors. The grievance advisor will refer complaints to the program's Steering Committee.

College of Agricultural and Life Sciences: Grievance Policy

In the College of Agricultural and Life Sciences (CALS), any student who feels unfairly treated by a member of the CALS faculty or staff has the right to complain about the treatment and to receive a prompt hearing. Some complaints may arise from misunderstandings or communication breakdowns and be easily resolved; others may require formal action. Complaints may concern any matter of perceived unfairness.

To ensure a prompt and fair hearing of any complaint, and to protect the rights of both the person complaining and the person at whom the complaint is directed, the following procedures are used in the College of Agricultural and Life Sciences. Any student, undergraduate or graduate, may use these procedures, except employees whose complaints are covered under other campus policies.

1. The student should first talk with the person at whom the complaint is directed. Most issues can be settled at this level. Others may be resolved by established departmental procedures.

2. If the student is unsatisfied, and the complaint involves any unit outside CALS, the student should seek the advice of the dean or director of that unit to determine how to proceed.
 - a. If the complaint involves an academic department in CALS the student should proceed in accordance with item 3 below.
 - b. If the grievance involves a unit in CALS that is not an academic department, the student should proceed in accordance with item 4 below.
3. The student should contact the department's grievance advisor within 120 calendar days of the alleged unfair treatment. The departmental administrator can provide this person's name. The grievance advisor will attempt to resolve the problem informally within 10 working days of receiving the complaint, in discussions with the student and the person at whom the complaint is directed.
 - a. If informal mediation fails, the student can submit the grievance in writing to the grievance advisor within 10 working days of the date the student is informed of the failure of the mediation attempt by the grievance advisor. The grievance advisor will provide a copy to the person at whom the grievance is directed.
 - b. The grievance advisor will refer the complaint to a department committee that will obtain a written response from the person at whom the complaint is directed, providing a copy to the student. Either party may request a hearing before the committee. The grievance advisor will provide both parties a written decision within 20 working days from the date of receipt of the written complaint.
 - c. If the grievance involves the department chairperson, the grievance advisor or a member of the grievance committee, these persons may not participate in the review.
 - d. If not satisfied with departmental action, either party has 10 working days from the date of notification of the departmental committee action to file a written appeal to the CALS Equity and Diversity Committee. A subcommittee of this committee will make a preliminary judgement as to whether the case merits further investigation and review. If the subcommittee unanimously determines that the case does not merit further investigation and review, its decision is final. If one or more members of the subcommittee determine that the case does merit further investigation and review, the subcommittee will investigate and seek to resolve the dispute through mediation. If this mediation attempt fails, the subcommittee will bring the case to the full committee. The committee may seek additional information from the parties or hold a hearing. The committee will present a written recommendation to the dean who will provide a final decision within 20 working days of receipt of the committee recommendation.
4. If the alleged unfair treatment occurs in a CALS unit that is not an academic department, the student should, within 120 calendar days of the alleged incident, take his/her grievance directly to the Associate Dean of Academic Affairs. The dean will attempt to resolve the problem informally within 10 working days of receiving the complaint. If this mediation attempt does not succeed the student may file a written complaint with the dean who will refer it to the CALS Equity and Diversity Committee. The committee will seek a written response from the person at whom the complaint is directed, subsequently following other steps delineated in item 3d above.

OTHER

We offer funding to all students in the program through fellowships, trainees and research assistantships.

PROFESSIONAL DEVELOPMENT

PROFESSIONAL DEVELOPMENT GRADUATE SCHOOL RESOURCES

Take advantage of the Graduate School's professional development resources (<https://grad.wisc.edu/pd/>) to build skills, thrive academically, and launch your career.

PROGRAM RESOURCES

In order to better train MDTP students for microbiology-related professions, students need a chance to gain knowledge and experience not just in academic research, but also in other fields where their microbiology education may be put to good use. Opportunities for professional development can consist of coursework, an internship, a summer workshop, outreach experiences, or a second teaching practicum experience. Professional Development plans must be approved by a student's thesis committee. Please see requirements (p.) for more information.

LEARNING OUTCOMES

LEARNING OUTCOMES

1. Gain a broad understanding of the microbiology principles that underlie all biological processes.
2. Articulate, discuss and define limits to the theory and knowledge in microbiology.
3. Think critically to address research challenges using a broad range of the theories, research methods, and approaches to scientific inquiry.
4. Communicates complex ideas in a clear and understandable matter.
5. Collaborate with investigators within the program, university, and beyond to advance the science of microbiology.
6. Foster professional and ethical conduct in the sciences.
7. Ethical design of experimental protocols.
8. Reproducibility of experimental results.
9. Professional behavior in industrial, government and academic settings.
10. Develop communication skills that enable the articulation of research to fellow scientists and non-scientists.
11. Develop teaching and mentoring skills in both lecture and laboratory settings.
12. Explore career development opportunities in industry, government, academia and private industry to realize professional goals.