

MICROBIOLOGY, B.S. (CALs)

Microbiology, the study of microorganisms, helps us understand our world and solve major problems. Microorganisms, or microbes, were the first life forms on earth and influence our lives and our planet in innumerable ways. The field of microbiology is constantly expanding as we learn more about the role of microbes in infectious disease, environmental remediation, bioenergy, food safety, antibiotic resistance, biotechnology and much more. Communities of microbes (or "microbiomes") are critically important in human health, global warming, agricultural yield, criminal justice, economic development and other issues of national concern.

The **microbiology major**, offered by the Department of Bacteriology, is a rigorous path of study, providing a curriculum packed with deep knowledge on broad aspects of microbiology and emphasizing modern laboratory skills. The core courses focus on the diversity, genetics, biochemistry, and physiology of microorganisms. A variety of elective courses provide the opportunity to study environmental microbiology, food microbiology, microbial pathogenesis, immunology, virology, microbiomes and microbial biotechnology, as well as advanced topics in microbial genetics and physiology. In the instructional laboratory courses, students learn beginning through advanced laboratory techniques—gaining the type of hands-on experiences with modern equipment that employers and graduate schools seek. Additionally, students can conduct mentored and independent research projects in faculty laboratories.

The bachelor's degree provides a strong background in the biological sciences for students planning to enter medical, dental, veterinary or other professional schools, as well as those planning graduate studies in any branch of microbiology or other biological sciences such as biochemistry, pathology, and molecular or cell biology.

Students who end their training with a bachelor's degree are well-prepared for a variety of career opportunities, including laboratory positions in pharmaceutical and biotechnology firms and in university and government laboratories. They also work as specialists in industrial quality testing and control, and as regulatory workers in government agencies and public health laboratories. Exposure to the scientific process as well as training in microbiology allows microbiology graduates to enter fields as diverse as business, technical service, sales, and technical writing.

HOW TO GET IN

Incoming or current students in good academic standing may declare the microbiology major at any time.

Schedule an appointment with a microbiology major advisor to discuss how to declare the major, appropriate coursework to take, and much more. Please see the Advising and Careers tab for information on how to schedule an appointment with a microbiology major advisor.

REQUIREMENTS

UNIVERSITY GENERAL EDUCATION REQUIREMENTS

All undergraduate students at the University of Wisconsin–Madison are required to fulfill a minimum set of common university general education requirements to ensure that every graduate acquires the essential core of an undergraduate education. This core establishes a foundation for living a productive life, being a citizen of the world, appreciating aesthetic values, and engaging in lifelong learning in a continually changing world. Various schools and colleges will have requirements in addition to the requirements listed below. Consult your advisor for assistance, as needed. For additional information, see the university Undergraduate General Education Requirements (<http://guide.wisc.edu/undergraduate/#requirementsforundergraduestudytext>) section of the *Guide*.

- | | |
|-------------------|--|
| General Education | <ul style="list-style-type: none"> • Breadth—Humanities/Literature/Arts: 6 credits • Breadth—Natural Science: 4 to 6 credits, consisting of one 4- or 5-credit course with a laboratory component; or two courses providing a total of 6 credits • Breadth—Social Studies: 3 credits • Communication Part A & Part B * • Ethnic Studies * • Quantitative Reasoning Part A & Part B * |
|-------------------|--|

* The mortarboard symbol appears before the title of any course that fulfills one of the Communication Part A or Part B, Ethnic Studies, or Quantitative Reasoning Part A or Part B requirements.

COLLEGE OF AGRICULTURAL AND LIFE SCIENCES REQUIREMENTS

In addition to the University General Education Requirements, all undergraduate students in CALS must satisfy a set of college and major requirements. Courses may not double count within university requirements (General Education and Breadth) or within college requirements (First-Year Seminar, International Studies, Science, and Capstone), but courses counted toward university requirements may also be used to satisfy a college and/or a major requirement; similarly, courses counted toward college requirements may also be used to satisfy a university and/or a major requirement.

COLLEGE REQUIREMENTS FOR ALL CALS B.S. DEGREE PROGRAMS

Code	Title	Credits
	Quality of Work: Students must maintain a minimum cumulative grade point average of 2.000 to remain in good standing and be eligible for graduation.	
	Residency: Students must complete 30 degree credits in residence at UW–Madison after earning 86 credits toward their undergraduate degree.	
	First Year Seminar (http://guide.wisc.edu/undergraduate/agricultural-life-sciences/#requirements-text)	1
	International Studies (http://guide.wisc.edu/undergraduate/agricultural-life-sciences/#requirements-text)	3

Physical Science Fundamentals	4-5
CHEM 103 General Chemistry I or CHEM 108 Chemistry in Our World or CHEM 109 Advanced General Chemistry	
Biological Science	5
Additional Science (Biological, Physical, or Natural)	3
Science Breadth (Biological, Physical, Natural, or Social)	3
CALs Capstone Learning Experience: included in the requirements for each CALs major (see "Major Requirements") (http://guide.wisc.edu/undergraduate/agricultural-life-sciences/#requirements)	

REQUIREMENTS FOR THE MAJOR

Code	Title	Credits
Mathematics		
Complete one of the following:		5-10
MATH 171 & MATH 217	Calculus with Algebra and Trigonometry I and Calculus with Algebra and Trigonometry II	
MATH 221	Calculus and Analytic Geometry 1	
Statistics		
Complete one of the following:		3
STAT 301	Introduction to Statistical Methods	
STAT 371	Introductory Applied Statistics for the Life Sciences	
General Chemistry		
Complete one of the following:		5-10
CHEM 103 & CHEM 104	General Chemistry I and General Chemistry II	
CHEM 109	Advanced General Chemistry	
CHEM 115 & CHEM 116	Chemical Principles I and Chemical Principles II	
Organic Chemistry		
Complete ALL of the following:		
CHEM 343	Introductory Organic Chemistry	3
CHEM 344	Introductory Organic Chemistry Laboratory	2
CHEM 345	Intermediate Organic Chemistry	3
Biology Foundation		
Complete one of the following:		10-13
BIOLOGY/ BOTANY/ ZOOLOGY 151 & BIOLOGY/ BOTANY/ ZOOLOGY 152	Introductory Biology and Introductory Biology ¹	
BIOCORE 381 & BIOCORE 382 & BIOCORE 383 & BIOCORE 384 & BIOCORE 485	Evolution, Ecology, and Genetics and Evolution, Ecology, and Genetics Laboratory and Cellular Biology and Cellular Biology Laboratory and Principles of Physiology ¹	

ZOOLOGY/ BIOLOGY 101 & ZOOLOGY/ BIOLOGY 102 & BOTANY/ BIOLOGY 130	Animal Biology and Animal Biology Laboratory and General Botany
---	---

Physics	
Select one of the following:	
PHYSICS 103 & PHYSICS 104	General Physics and General Physics ²
PHYSICS 207 & PHYSICS 208	General Physics and General Physics ²
PHYSICS 201 & PHYSICS 202	General Physics and General Physics

Biochemistry	
Complete one of the following:	
BIOCHEM 501	Introduction to Biochemistry
BIOCHEM 507 & BIOCHEM 508	General Biochemistry I and General Biochemistry II

Microbiology Courses		
<i>Microbiology Core (all required):</i>		
Except where noted, all Microbiology Core courses are offered every fall and spring semester.		
MICROBIO 303	Biology of Microorganisms	3
MICROBIO 304	Biology of Microorganisms Laboratory	2
MICROBIO 305	Critical Analyses in Microbiology	1
MICROBIO 450	Diversity, Ecology and Evolution of Microorganisms	3
MICROBIO 470	Microbial Genetics & Molecular Machines	3
MICROBIO 526	Physiology of Microorganisms	3
MICROBIO 527	Advanced Laboratory Techniques in Microbiology (FALL ONLY)	2

<i>Microbiology Capstone (required):</i>		
MICROBIO 551	Capstone Research Project in Microbiology (SPRING ONLY)	2

<i>Microbiology Electives</i>		
Complete at least 6 credits; at least 3 credits must come from Set A. Note that not all elective courses are offered every semester.		

Set A:		3-6
MICROBIO/ FOOD SCI 324	Food Microbiology Laboratory	
MICROBIO/ FOOD SCI 325	Food Microbiology	
MICROBIO 330	Host-Parasite Interactions	
MICROBIO/ AN SCI/ BOTANY 335	The Microbiome of Plants, Animals, and Humans	
MICROBIO 345	Introduction to Disease Biology	
MICROBIO/SOIL SCI 425	Environmental Microbiology	
MICROBIO/SOIL SCI 523	Soil Microbiology and Biochemistry	

MICROBIO/ ONCOLOGY 545	Topics in Biotechnology (topics vary by semester)	
MICROBIO 607	Advanced Microbial Genetics	
MICROBIO/ BIOCHEM/ GENETICS 612	Prokaryotic Molecular Biology	
MICROBIO 657	Bioinformatics for Microbiologists	
MICROBIO/ BMOLCHEM 668	Microbiology at Atomic Resolution	
Set B:		0-3
BIOCHEM 570	Computational Modeling of Biological Systems	
BIOCHEM/M M & I 575	Biology of Viruses	
BIOCHEM 601	Protein and Enzyme Structure and Function	
BOTANY 330	Algae	
BOTANY/PL PATH 332	Fungi	
BOTANY/ENTOM/ PL PATH 505	Plant-Microbe Interactions: Molecular and Ecological Aspects	
CHEM 565	Biophysical Chemistry	
COMP SCI/ B M I 576	Introduction to Bioinformatics	
F&W ECOL/SURG SCI 548	Diseases of Wildlife	
FOOD SCI 550	Fermented Foods and Beverages	
M M & I 301	Pathogenic Bacteriology	
M M & I 341	Immunology	
M M & I/ENTOM/ PATH-BIO/ ZOOLOGY 350	Parasitology	
M M & I 554	Emerging Infectious Diseases and Bioterrorism	
M M & I 555	Vaccines: Practical Issues for a Global Society	
M M & I/POP HLTH 603	Clinical and Public Health Microbiology	
ONCOLOGY/ PL PATH 640	General Virology-Multiplication of Viruses	
PATH-BIO/ M M & I 528	Immunology	
PL PATH 622	Plant-Bacterial Interactions	
PL PATH/ BOTANY/ GENETICS/ M M & I 655	Biology and Genetics of Fungi	
Total Credits		64-88

¹ (BIOLOGY/BOTANY/ZOOLOGY 151 and BIOLOGY/BOTANY/ZOOLOGY 152) or (BIOCORE 381 / BIOCORE 382 / BIOCORE 383 / BIOCORE 384 / BIOCORE 485) are recommended.

² (PHYSICS 103 / PHYSICS 104) or (PHYSICS 207 / PHYSICS 208) are recommended.

HONORS IN THE MAJOR

Students admitted to the university and to the College of Agricultural and Life Sciences are invited to apply to be considered for admission to the CALS Honors Program.

Admission Criteria for New First-Year Students:

- Complete program application including essay questions

Admission Criteria for Transfer and Continuing UW-Madison Students:

- UW-Madison cumulative GPA of at least 3.25
- Complete program application including essay questions

HOW TO APPLY

The application is available on the CALS Honors Program website (<https://cals.wisc.edu/academics/undergraduate-students/outside-the-classroom/honors-program/>). Applications are accepted at any time.

New first-year students with accepted applications will automatically be enrolled in Honors in Research. It is possible to switch to Honors in the Major in the student's first semester on campus after receiving approval from the advisor for that major. Transfer and continuing students may apply directly to Honors in Research or Honors in the Major (after approval from the major advisor).

REQUIREMENTS

All CALS Honors programs have the following requirements:

- Earn at least a cumulative 3.25 GPA at UW-Madison (some programs have higher requirements)
- Complete the program-specific requirements listed below
- Submit completed thesis documentation to CALS Academic Affairs

HONORS IN THE MAJOR IN MICROBIOLOGY: REQUIREMENTS

To earn Honors in the Major in Microbiology, students must satisfy the Requirements for the Major (above) as well as the following requirements. All courses used for Honors in the Major requirements must receive "B" or better grades to fulfill requirements.

- Earn a 3.300 overall university GPA.
- Earn a 3.300 GPA for all MICROBIO courses, and all courses accepted in the major.
- Complete a two-semester Senior Honors Thesis (MICROBIO 681 and MICROBIO 682) for 6 credits total and present research in a public forum. Students completing their senior honors theses in laboratories or departments outside of Microbiology may be able to count that thesis toward Honors in the Major.
- Complete at least 20 credits of any combination of the following coursework:
 - Honors courses that fulfill Requirements for the Major (see above); independent study and thesis credits do not count here.
 - Non-honors coursework credits from this list: CHEM 115, CHEM 311, CHEM 327, GENETICS 466, MATH 222, MATH 234. These courses do not need to be taken for honors to count.
- At least 10 of the 20 credits of coursework above must come from courses taken for honors off this Microbiology course list: MICROBIO 303, MICROBIO 304, MICROBIO/FOOD SCI 325, MICROBIO 330, MICROBIO/AN SCI/BOTANY 335, MICROBIO 345,

MICROBIO/SOIL SCI 425, MICROBIO 450, MICROBIO 470, MICROBIO 526, MICROBIO 607, MICROBIO/BIOCHEM/GENETICS 612, MICROBIO 657, MICROBIO/BMOLCHEM 668.

UNIVERSITY DEGREE REQUIREMENTS

Total Degree To receive a bachelor's degree from UW–Madison, students must earn a minimum of 120 degree credits. The requirements for some programs may exceed 120 degree credits. Students should consult with their college or department advisor for information on specific credit requirements.

Residency Degree candidates are required to earn a minimum of 30 credits in residence at UW–Madison. "In residence" means on the UW–Madison campus with an undergraduate degree classification. "In residence" credit also includes UW–Madison courses offered in distance or online formats and credits earned in UW–Madison Study Abroad/Study Away programs.

Quality of Work Undergraduate students must maintain the minimum grade point average specified by the school, college, or academic program to remain in good academic standing. Students whose academic performance drops below these minimum thresholds will be placed on academic probation.

Math ²	3-5 CHEM 345	3
Intro Biology, Semester 1 ⁴	5 Intro Biology, Semester 2 ⁴	5
Elective ³	3 Electives ³	6
14-16		16

Junior			
Fall	Credits	Spring	Credits
General Physics, Semester 1 ⁵		4-5 General Physics, Semester 2 ⁵	4-5
MICROBIO 303		3 MICROBIO 470	3
MICROBIO 304		2 BIOCHEM 501 ⁷	3
MICROBIO 305		1 Research ⁶	1-4
Research ⁶		1-4 Electives (for major or other) ³	0-4
Electives (to reach 15 crs) ³		0-4	
11-19		11-19	

Senior			
Fall	Credits	Spring	Credits
MICROBIO 526		3 MICROBIO 450	3
MICROBIO 527		2 MICROBIO 551	2
Research ⁶		1-4 Research ⁶	1-4
Electives (for major or other) ³		6-9 Electives (for major or other) ³	7-10
12-18		13-19	

Total Credits 105-138

* Students planning to pursue graduate studies in a biological science are encouraged to take MATH 222, PHYSICS 201/ PHYSICS 202 or PHYSICS 207/PHYSICS 208, and BIOCHEM 507/BIOCHEM 508 (see Note 7). Also recommended: CHEM 565 Biophysical Chemistry and MICROBIO/BIOCHEM/GENETICS 612 Prokaryotic Molecular Biology.

¹ Choose 1 of 3 sequences: (CHEM 103/CHEM 104) or CHEM 109 or (CHEM 115/CHEM 116). Students who take CHEM 109 and plan to attend medical or other professional schools are advised to take one additional inorganic course (CHEM 311 or CHEM 327).

² Math course determined by placement scores. Microbiology majors must complete math through calculus (choose from MATH 171/MATH 217 or MATH 221), and statistics (choose from STAT 301 or STAT 371).

³ Electives can be scheduled according to the student's preference. Consult your advisor and the Requirements tab.

⁴ The three choices are 1) ZOOLOGY/BIOLOGY/BOTANY 151 and ZOOLOGY/BIOLOGY/BOTANY 152; 2) ZOOLOGY/BIOLOGY 101, ZOOLOGY/BIOLOGY 102 and BOTANY/BIOLOGY 130; or 3) Biocore. Biocore is a 3 to 4 semester sequence. Students must complete the first three lectures and the first two labs. The Biocore courses are BIOCORE 381, BIOCORE 382, BIOCORE 383, BIOCORE 384, BIOCORE 485, BIOCORE 486, BIOCORE 587.

⁵ Physics may be taken in year 1, 2, 3, or 4 depending on the student's schedule.

⁶ Undergraduate research courses include 299, 699, 681#682 (Honors Thesis), 691#692 (Thesis). Both semesters are required for thesis credit. Students are encouraged to take several semesters of research (internship opportunities, 399, are also encouraged).

⁷ If BIOCHEM 507 General Biochemistry I and BIOCHEM 508 General Biochemistry II are taken, both semesters must be completed (with

LEARNING OUTCOMES

1. Develop a fundamental understanding of the principles of microbiology and the necessary skills for a professional career in microbiology
2. Apply the scientific method to questions. Formulate a hypothesis, gather data, and analyze that data to assess the degree to which their work supports the hypothesis.
3. Demonstrate proficiency in the techniques used in microbiology and an ability to critically analyze data and integrate ideas for problem solving
4. Access the primary and secondary literature and, in combination with their own findings, effectively communicate their ideas both orally and in written form.
5. Learn about and demonstrate personal and professional ethics.

FOUR-YEAR PLAN

FOUR-YEAR PLAN

SAMPLE MICROBIOLOGY FOUR-YEAR PLAN

Freshman

Fall	Credits	Spring	Credits
General Chemistry ¹		4-5 Gen Chem or Electives ¹	5
Math ²		3 Math ²	3-5
COMM-A		3 Electives ³	6
First-Year Seminar		1	
Elective ³		3	
14-15		14-16	

Sophomore

Fall	Credits	Spring	Credits
CHEM 343		3 CHEM 344	2

the recommendation of BIOCHEM 507 in fall semester of year 3 and BIOCHEM 508 in spring semester of year 3).

THREE-YEAR PLAN

This sample three-year plan is a tool to assist students and their advisor(s). Students should use it —along with their DARS report, the Degree Planner, and Course Search & Enroll tools — to make their own three-year plan based on their placement scores, credit for transferred courses and approved examinations, and individual interests.

Three-year plans may vary considerably from student to student, depending on their individual preparation and circumstances. Students interested in graduating in three years should meet with an academic advisor early and often to discuss feasibility, appropriate course sequencing, post-graduation plans (careers, graduate school, etc.), and considerations they might make in pursuit of a three-year graduation plan.

While there are many advantages to attending four years of college, including making the most of research and study abroad opportunities, exploring alternative majors, completing additional majors and certificates, developing skills and interests through student groups, and personal growth, students may have reasons for wishing to graduate in fewer than four years.

The example plan assumes that students will:

- enter their freshman year with 20 advanced standing credits, including equivalency credit for MATH 221
- declare their major freshman year
- take two summer terms
- enroll in at least 15-16 credits in the fall/spring semesters

Code	Title	Credits		
Courses taken the summer before arriving on campus				
INTER-AG 140	CALS QuickStart: Foundations	1		
INTER-AG 141	QuickStart: Connect2Campus	1		
<i>Total Credits:</i>		2		
First Year				
Fall	Credits Spring	Credits Summer	Credits	
CHEM 103	4 CHEM 104	5 MICROBIO 303	3	
Comm A Requirement	3 BIOLOGY/ BOTANY/ ZOOLOGY 151	5 MICROBIO 304	2	
STAT 371 or 301	3 Elective	3		
Humanities breadth	3 Humanities breadth	3		
Social Science breadth	3			
		16	16	5
Second Year				
Fall	Credits Spring	Credits		
CHEM 343	3 CHEM 345	3		
BIOLOGY/ BOTANY/ ZOOLOGY 152	5 CHEM 344	2		

MICROBIO 470	3 BIOCHEM 501	3
International Studies CALS requirement	3 MICROBIO 305	1
Elective	2 Elective ²	3
Ethnic Studies		3
16		15
Third Year		
Fall	Credits Spring	Credits
MICROBIO 527	2 MICROBIO 551	2
MICROBIO 450	3 MICROBIO 526	3
PHYSICS 103 or 207	4-5 PHYSICS 104 or 208	4-5
Major Elective	3 Major Elective	3
Elective ²	3 Elective ²	3
15-16		15-16

Total Credits 98-100

Students must earn **120 total credits** to graduate, including accepted advanced standing or transfer credits. The above charts reflect 100-102 total credits from six fall/spring semesters and two summer terms, including courses taken in the summer before the first year.

- ¹ The Microbiology major recommends QuickStart (INTER-AG 140 and INTER-AG 141) for the First-Year Seminar requirement. However, this requirement can be fulfilled through courses offered in Fall and Spring semester of the first year.
- ² The Microbiology major encourages students with an interest in research to work with faculty through Independent Research courses as electives.

ADVISING AND CAREERS

Current UW–Madison students should use Starfish to schedule an appointment with an advisor in the Biochemistry & Microbiology Undergraduate Advising Hub (<https://biochemmicrobio.wisc.edu/>).

Prospective/future UW–Madison students should send an email to the Biochemistry & Microbiology Undergraduate Advising Hub (biochemmicrobio-advisor@wisc.edu) to set up an appointment, which can be conducted in person or via phone call.

Read about and explore possible microbiology careers at the American Society for Microbiology (<https://www.asm.org/Careers/Career-Planning/>) website.

Learn more about health-related careers through ExploreHealthCareers.org (<https://explorehealthcareers.org/>).

PEOPLE

PROFESSORS

Katrina Forest (Chair), Jean-Michel Ané, Cameron Currie, Timothy Donohue, Richard Gourse, Charles Kaspar, Katherine McMahon, Michael Thomas, Jade (Jue) Wang, Karen Wassarman, Jae-Hyuk Yu

ASSOCIATE PROFESSORS

Daniel Amador-Noguez, Briana Burton, Federico Rey, Garret Suen

ASSISTANT PROFESSORS

Karthik Anantharaman, Kerri Coon, David Hershey, Erica Lois-Wunderlich
Majumder