**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/#requirementsforundergraduatestudytext) section of the Guide.

<table>
<thead>
<tr>
<th>General Education</th>
<th>Credits</th>
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<tbody>
<tr>
<td>• Breadth—Humanities/Literature/Arts: 6 credits</td>
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<tr>
<td>• 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</td>
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<tr>
<td>• Breadth—Social Studies: 3 credits</td>
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<tr>
<td>• Communication Part A &amp; Part B*</td>
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<tr>
<td>• Ethnic Studies*</td>
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<tr>
<td>• Quantitative Reasoning Part A &amp; Part B*</td>
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</tr>
</tbody>
</table>

* 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

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
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</tr>
<tr>
<td>Residency: Students must complete 30 degree credits in residence at UW–Madison after earning 86 credits toward their undergraduate degree.</td>
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<tr>
<td>First Year Seminar (<a href="http://guide.wisc.edu/undergraduate/agricultural-life-sciences/#requirementstext">http://guide.wisc.edu/undergraduate/agricultural-life-sciences/#requirementstext</a>)</td>
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</tr>
<tr>
<td>International Studies (<a href="http://guide.wisc.edu/undergraduate/agricultural-life-sciences/#requirementstext">http://guide.wisc.edu/undergraduate/agricultural-life-sciences/#requirementstext</a>)</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>
### Physical Science Fundamentals

- **CHEM 103**: General Chemistry I
- or **CHEM 108**: Chemistry in Our World
- or **CHEM 109**: Advanced General Chemistry

### Biological Science

- Additional Science (Biological, Physical, or Natural): 3 credits
- Science Breadth (Biological, Physical, Natural, or Social): 3 credits

CALS Capstone Learning Experience: included in the requirements for each CALS major (see 'Major Requirements') (http://guide.wisc.edu/undergraduate/agricultural-life-sciences/#requirementstext)

## REQUIREMENTS FOR THE MAJOR

<table>
<thead>
<tr>
<th>Code</th>
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<th>Credits</th>
</tr>
</thead>
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<td><strong>Mathematics</strong></td>
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<tr>
<td>Select one of the following:</td>
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<td></td>
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<tr>
<td>MATH 171 &amp; MATH 217</td>
<td>Calculus with Algebra and Trigonometry I and Calculus with Algebra and Trigonometry II</td>
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<tr>
<td>MATH 221</td>
<td>Calculus and Analytic Geometry I</td>
<td></td>
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<tr>
<td><strong>Statistics</strong></td>
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<td>3</td>
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<tr>
<td>Select one of the following:</td>
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<tr>
<td>STAT 301</td>
<td>Introduction to Statistical Methods</td>
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<tr>
<td>STAT 371</td>
<td>Introductory Applied Statistics for the Life Sciences</td>
<td></td>
</tr>
<tr>
<td>STAT/B M 1 541</td>
<td>Introduction to Biostatistics</td>
<td></td>
</tr>
<tr>
<td><strong>General Chemistry</strong></td>
<td></td>
<td>5-9</td>
</tr>
<tr>
<td>Select one of the following:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHEM 103 &amp; CHEM 104</td>
<td>General Chemistry I and General Chemistry II</td>
<td></td>
</tr>
<tr>
<td>CHEM 109</td>
<td>Advanced General Chemistry</td>
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</tr>
</tbody>
</table>

**Organic Chemistry**

Select 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**

Select one of the following: 10-13

- BIOLOGY/ BOTANY/ ZOOLOGY 151 & BIOLOGY/ BOTANY/ ZOOLOGY 152
- 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

**ZOOLOGY/ Animal Biology**

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

**Physics**

Select one of the following: 8-10

- PHYSICS 103 & PHYSICS 104: General Physics and General Physics
- PHYSICS 207 & PHYSICS 208: General Physics and General Physics
- PHYSICS 201 & PHYSICS 202: General Physics and General Physics

**Biochemistry**

Select one of the following: 3-6

- BIOCHEM 501: Introduction to Biochemistry
- BIOCHEM 507 & BIOCHEM 508: General Biochemistry I and General Biochemistry II

**Microbiology Courses**

**Microbiology Core (all required):**

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

**Microbiology Capstone (required):**

- MICROBIO 551: Capstone Research Project in Microbiology (SPRING ONLY) 2

**Microbiology Electives**

Select 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 375: Special Topics
- MICROBIO/SOIL SCI 425: Environmental Microbiology
- MICROBIO/SOIL SCI 523: Soil Microbiology and Biochemistry
- PATH/BIO/ M M & I 528: Immunology
- MICROBIO/ ONCOLOGY 545: Topics in Biotechnology (topics vary by semester)
HONORS IN THE MAJOR

Admission to the Honors Program is not competitive provided students meet the required admission criteria.

Admission Criteria for New Freshmen:

• In the upper 10% of their high school graduating class
• ACT score of 28 or higher
• SAT score of at least 1240

Admission Criteria for Transfer and Continuing UW-Madison Students:

• UW-Madison cumulative GPA of at least 3.25

Highly motivated students can apply for admission to the program in the absence of these requirements by including a letter with their application addressed to the Honors Dean in 116 Agricultural Hall explaining why they should be in the program.

HOW TO APPLY

Apply to the program online (https://cals.wisc.edu/wp-content/uploads/2017/05/honorsapplication_form.pdf) or request an application in the Office of Academic Affairs, 116 Agricultural Hall. Applications are accepted at any time.

New freshmen 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 meeting with the advisor for that major by completing the application form and selecting Honors in the Major. Transfer and continuing students may apply directly to Honors in Research or Honors in the Major (after meeting with the major advisor).

HOW TO CANCEL PARTICIPATION

Students who are no longer interested in pursuing Honors should contact the CALS Honors Program Manager (see the contact box for CALS Honors Program (http://guide.wisc.edu/undergraduate/agricultural-life-sciences/college-wide/college-agricultural-life-sciences-honors/)). Students may cancel their participation at any time, and this will not be noted on the student’s transcript.

REQUIREMENTS

To earn Honors in the Major, students are required to take at least 20 honors credits. In addition, students must take MICROBIO 681 Senior Honors Thesis and MICROBIO 682 Senior Honors Thesis when completing their thesis project; please see the Honors in Major Checklist (http://www.cals.wisc.edu/academics/undergraduate-programs/get-involved/honors-program/honors-in-the-major/) for more information.

UNIVERSITY DEGREE REQUIREMENTS

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.
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

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
Total 14-15 14-16

Sophomore

Fall Credits Spring Credits
CHEM 343 3 CHEM 344 2
Math 2 3-5 CHEM 345 3
Intro Biology, Semester 1 5 Intro Biology, Semester 2 4
Elective 3 3 Electives 3 6
Total 14-16 16

Junior

Fall Credits Spring Credits
General Physics, Semester 1 4-5 General Physics, Semester 2 4-5
MICROBIO 303 3 MICROBIO 470 3

Senior

Fall Credits Spring Credits
MICROBIO 304 2 BIOCHEM 501 or BMOLCHEM 503 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
Total 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
Total 12-18 13-19

Total Credits 105-138

* Students planning to pursue graduate studies in a biological science are encouraged to take MATH 221, MATH 222, PHYSICS 201/ PHYSICS 202 or PHYSICS 207/PHYSICS 208, and BIOCHEM 507/BIOCHEM 508 (see Note 7). Additionally recommended: CHEM 565 Biophysical Chemistry and MICROBIO/BIOCHEM/ GENETICS 612 Prokaryotic Molecular Biology.

1 Choose 1 of 2 sequences: CHEM 103/CHEM 104 or CHEM 109. 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. Microbio majors must complete math through calculus (choose from MATH 171/MATH 217 or MATH 221), and statistics (choose from STAT 301, STAT 371, or STAT/B M I 541).

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 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 the recommendation of BIOCHEM 507 General Biochemistry I in fall semester of year 3 and BIOCHEM 508 General Biochemistry II 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

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Courses taken the summer before arriving on campus</td>
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</tr>
<tr>
<td>INTER-AG 140</td>
<td>CALS QuickStart: Foundations</td>
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</tr>
<tr>
<td>INTER-AG 141</td>
<td>QuickStart: Connect2Campus</td>
<td>1</td>
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<tr>
<td><strong>Total Credits:</strong></td>
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</table>

**First Year**

<table>
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<tr>
<th>Fall</th>
<th>Credits Spring</th>
<th>Credits Summer</th>
<th>Credits</th>
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<tbody>
<tr>
<td>CHEM 103</td>
<td>4 CHEM 104</td>
<td>5 MICROBIO 303</td>
<td>3</td>
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<tr>
<td>Comm A Requirement</td>
<td>3 BIOLOGY/BOTANY/ZOOLOGY 151</td>
<td>5 MICROBIO 304</td>
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<tr>
<td>STAT 371 or 301</td>
<td>3 Elective</td>
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<td>3</td>
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<tr>
<td>Humanities breadth</td>
<td>3 Humanities breadth</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Social Science breadth</td>
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<td></td>
<td></td>
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<tr>
<td><strong>First Year</strong></td>
<td></td>
<td></td>
<td>16 16 5</td>
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**Second Year**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Credits Spring</th>
<th>Credits</th>
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<tbody>
<tr>
<td>CHEM 343</td>
<td>3 CHEM 345</td>
<td>3</td>
</tr>
<tr>
<td>BIOLOGY/BOTANY/ZOOLOGY 152</td>
<td>5 CHEM 344</td>
<td>2</td>
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<tr>
<td>MICROBIO 470</td>
<td>3 BIOCHEM 501</td>
<td>3</td>
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<tr>
<td>International Studies CALS requirement</td>
<td>3 MICROBIO 305</td>
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<tr>
<td>Elective</td>
<td>2 Elective^2</td>
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<td>Ethnic Studies</td>
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<td><strong>Second Year</strong></td>
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**Third Year**

<table>
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<tbody>
<tr>
<td>MICROBIO 527</td>
<td>2 MICROBIO 551</td>
<td>2</td>
</tr>
<tr>
<td>MICROBIO 450</td>
<td>3 MICROBIO 526</td>
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<td>PHYSICS 103 or 207</td>
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<td>Major Elective</td>
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<td>Elective^2</td>
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<tr>
<td><strong>Third Year</strong></td>
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</table>

**Total Credits 98-100**

Students must earn **120 total credits** to graduate, including accepted advanced standing or transfer credits. The above chart reflects 100-102 total credits from six fall/spring semesters and two summer terms.

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**
Ané, Currie, Donohue, Filutowicz, Forest, Gourse, Johnson, Kaspar (chair), McMahon (Civil and Environmental Engineering), Thomas, Wang, Wassarman, Yu

**ASSOCIATE PROFESSOR**
Burton, Rey, Suen

**ASSISTANT PROFESSORS**
Amador-Noguez, Anantharaman