

UNDERGRADUATE  
PROGRAM IN  
MICROBIOLOGY

UMassAmherst



University of Massachusetts  
Department of Microbiology  
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For questions about the  
Microbiology Undergraduate Program:

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Undergraduate Program Director  
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Current students can make an appointment at:

<https://umass.campus.eab.com>

Peer Advising office is room 339 Morrill I.

## ***The Department of Microbiology***

The Department of Microbiology consists of an energetic faculty and student body. Currently, the department consists of 24 faculty members, 35 graduate students and approximately 200 undergraduates. **Microbiology** is an exciting and rapidly advancing field that requires a strong foundation in molecular biology, cellular biology, genetics, ecology and evolution. The field occupies a central place in the life sciences, and we are committed to providing our students with the knowledge and tools to enter this expanding field of study.

**Microbiology** focuses on the biology of bacteria, archaea, fungi, viruses, and the immune system to better understand our world and determine solutions to challenges facing society. Developments in **biotechnology, medicine, environmental studies and genetics** continue to draw Microbiology onto the center stage.

**Biotechnology** is fundamental to solving some of the world's largest and persistent challenges. Microorganisms play key role in allowing innovative biotechnology. Microorganisms have already created many biological innovations, we just need to understand these innovations better and determine how best to use microbes for our benefit. In **medicine**, infectious diseases caused by microorganisms are of central importance, with recent reports indicating that these diseases are the 3<sup>rd</sup> leading cause of death in the world. Vaccine development and the search for new drugs to fight infectious diseases are thriving areas of research. **Environmental studies** include the use of microorganisms to create renewable energy sources or use bioremediation to clean up polluted environments. Microbes also play a major role in regulating greenhouse gases, regulating basic ecosystem processes, and determining the distribution and diversity of plants and animals. Indeed, microorganisms are everywhere and have a central role in the environmental and human health.

The Department of Microbiology is excited by developments in these fields. We look forward to an opportunity to provide you with the knowledge and skills to participate in these interesting areas where employment prospects are excellent. Undergraduate Microbiology majors are exposed to courses and laboratories in General Microbiology, Genetics, Physiology, Immunology, Infection and Immunity, Parasitology, Virology and Ecology. Students have the opportunity to participate in research projects with the faculty and graduate students, meet with our alumni, and enjoy a "small college atmosphere" in a major with classes of 30-70 students.

## General Education Requirements for Students Enrolling as Freshmen in the Fall of 2018 or Later

Curriculum Area	Number of courses	Number of credits earned	Fulfilling the Requirement
Writing	2 courses	6 credits	One course (CW) or exemption (see Writing Program) and one upper level 3-credit course in your major department
Basic Mathematics	1 course	0-3 credits	One course (R1) or a passing score on the Tier 1 Math Exemption Exam
Analytic Reasoning	1 course	3 credits	One course (R2)
Biological & Physical World	2 courses	8 credits	One course (BS) and one course (PS)
Social World & Diversity	4 courses	16 credits	<p>One course in AL/AT (or in AL/ATDU or AL/ATDG), one course HS (or in HSDU or HSDG), one course SB (or SBDU or SBDG), and one course (AL, AT, SB, I, or SI or any of these in combination with DU or DG)</p> <p>Students must take one course with DU designation and one course with DG designation. <i>Either a DU or a DG course must be taken during the student's first year on campus.</i></p>
Integrative Experience	Three 1 credit modules	3 credits	Choose 3: Microbio 494PI, 494SI, 494BI, 494DI, 494FI, 494GI, 494MI, 494NI, 494 QI, 494VI

# Microbiology Undergraduate Degree Program

*This schedule is for illustrative purposes only. Many variations are possible. Please consult with your advisor to plan your academic schedule. 35 Microbiology credits required.*

## Fall

### Freshman

Chem 111 General Chemistry (4 cr)\*<sup>1</sup>

Biol 151 (4 cr)\*<sup>1, 2</sup>

Math 127 Calc for Life Sci Majors (3 cr)<sup>3</sup>

Eng 112 College Writing (3 cr)

### Sophomore

Microbio 311 Foundations in Microbio (3 cr)\*\*

Microbio 312 General Microbiology Lab (3 cr)\*\*

Chem 261 Organic Chemistry I (3 cr) \*

Gen Ed (4 cr)

Gen Ed (4 cr)

### Junior

Physics 131 Intro Physics I (4 cr)

Microbio 320 Infectious Disease & Defense (3cr)

Biochem 420 Elementary Biochemistry (3 cr)

### Senior

Major Laboratory Elective

2 Major Electives

Integrative Experience (3 cr)

OR

## Spring

Chem 112 General Chemistry II (4 cr)\*

Biol 152 (3 cr)\*<sup>2</sup>

Biol 153 (2 cr)

Math 128 Calc for Life Sci Majors or  
Statistic 240 Statistics (3 cr)<sup>3</sup>

Gen Ed with DU/DG designation (4 cr)

Chem 262 Organic Chemistry II (3 cr)

Chem 269 Organic Chemistry Lab (2 cr)

Microbio 330 Microbial Genetics (3 cr)

Gen Ed (4 cr) or Major Elective

Gen Ed (4 cr)

Physics 132 Intro Physics II (4 cr)

Major Elective

Microbio 360 Junior Writing (3 cr) (Fall or Sp)

Microbio 480 Microbial Physiology  
& Diversity (3 cr)

Major Laboratory Elective

Integrative Experience (3 cr)

*35 Microbiology credits must be completed. Specific requirements include Microbio 310, 312, 320, 330, 360, 480 and 3 credits of Integrative Experience (494). Only 3 credits of Independent Study (396) or Practicum (398) may be applied to the 35 credit requirement.*

*\*Minimal grade of C- or higher required. \*\*Minimal grade of C or higher required in these courses.*

<sup>1</sup> Will fulfill Biological & Physical World GENED Requirements

<sup>2</sup> Biology Department requires a C in Bio 151 to enroll in Bio 152

<sup>3</sup> Will fulfill R1 and R2 GENED Requirements

## Advising for Microbiology Majors

Heather Reed – 337 Morrill Science Center I  
hreed@umass.edu

Chief Undergraduate Advisor and Undergraduate Program Director

You can make advising appointments using the following URL

<https://umass.campus.eab.com>

or by e-mailing  
hreed@umass.edu

Peer Advising Office – 339 Morrill Science Center I

See <https://www.micro.umass.edu> for Peer Advising office hours.

## The Integrative Experience Requirement for Microbiology Majors

There are presently *two options* available for Microbiology majors to fulfill the Integrative Experience Requirement.

**Option 1** - The IE in Microbiology (Microbio 494) consists of three 1-credit modular courses. These courses will be offered every semester, with different faculty featured each semester. The Fall IE courses will be offered on MWF at 12:20. Spring courses will be offered on MWF at 11:15. Each module will be worth 1 credit and be offered for a *third of the semester*, at the same course schedule day and time.

**OR**

**Option 2** - Students complete NATSCI 494I – a team-based learning course offered through the College of Natural Sciences. This 3-credit course features three modules taught in a TBL environment. The course will be offered in the Spring.

# Biotechnology Certificate

## Program Director: Professor John Burand

202A Fernald Tel: 545-3629

Email: [jburand@microbio.umass.edu](mailto:jburand@microbio.umass.edu)

[www.micro.umass.edu/undergraduate/biotechnology-certificate-program](http://www.micro.umass.edu/undergraduate/biotechnology-certificate-program)

### REQUIREMENTS

Students must take a minimum of 15 credits of approved courses related to the area of biotechnology. These courses will include an **introductory course** in biotechnology and/or molecular biology such as ANIMLSCI, BIOCHEM, or BIOLOGY 285 (3 credits) - Cellular & Molecular Biology or the equivalent (see website for details), **MICROBIO 385 - Laboratory in Biotechnology** (4 credits), a laboratory based **independent study or internship** (3 credits minimum) and a **minimum of 5 credits of biotechnology related courses**.

Students enrolled in the Certificate Program will be required to maintain a GPA of 2.50 or higher in courses in the program and no course with a grade lower than a C will be counted toward the Certificate. **NOTE: No more than 2 courses used to fulfill certificate requirements can be applied to fulfill another credential (e.g. major, minor, or certificate).**

Undergraduates interested in this Certificate Program should contact the Program Director and submit an application.

Application for this Certificate Program available at:

[www.micro.umass.edu/sites/default/files/pdf-attachments/Biotech-Cert-Application.pdf](http://www.micro.umass.edu/sites/default/files/pdf-attachments/Biotech-Cert-Application.pdf)

## Microbiology Departmental Honors

### Honor Program Director: Professor Kristen DeAngelis

N573 Life Sciences Lab, Tel: 413-577-4669

Email: [deangelis@microbio.umass.edu](mailto:deangelis@microbio.umass.edu)

### Departmental Honors

The Commonwealth Honors College (CHC) is the home of the honors program on the University of Massachusetts campus. The Microbiology Department offers Microbiology majors the option to enroll in Departmental Honors (DH), an Advanced Scholarship Track of CHC. Participation in Microbiology Departmental Honors requires admission to the program.



## How to Apply

Students in the Microbiology major who are currently members of the CHC can apply for admission to the Departmental Honors by contacting the Department's Honors Program Director, Professor Kristen DeAngelis. For Microbiology majors who are not yet members of the CHC, apply for admission to Departmental Honors via the CHC on-line application process.

## Required Course Work

### **MICROBIO 391H: The Secret Lifestyle of Microorganisms, Honors Colloquium for Microbiology 311 (1 cr) (Spring)**

A small group tutorial discussion: the role of science in society combined with discussions of contemporary societal issues **involving** microbiology such as emerging infectious diseases and microbial biotechnology.

### **MICROBIO 396/MICROBIO 396ISH Independent Study (ISH usually 3 cr)**

Program participants will undertake an honors section of independent study under the direction of their research sponsor. (You will need to fill out an Independent Study Honors Contract with the Commonwealth Honors College Office)

### **MICROBIO 499Y Honors Research (3 cr, Fall, Senior Year)**

Original microbiological research carried out under the direction of the research sponsor. The honors student will take an active role in the experimental design of the research project. The expectation is that participation in the design and implementation of a research project will help the student acquire the necessary skills to carry out independent research.

### **Microbio 499P Honors Project (Capstone Experience) (3 cr, Spring, Senior Year)**

The honors project consists of completing and presenting original research. The presentation will include but not be limited to an abstract suitable for publication and a research summary in the form of a poster appropriate for presentation at a scientific meeting. A departmental poster presentation session will be held at the end of the semester. Students must also complete the Manuscript requirement for CHC.

## **Fifth Year Master's Program in Microbiology**

The **Department of Microbiology** offers a special **5<sup>th</sup> Year Master's Program** designed **exclusively** for its **undergraduate Microbiology majors**.

This program is appropriate for academically strong students who are interested in enhancing their academic and research background before entering the professional world.

UMASS Microbiology majors who are interested in this program are strongly advised to meet with their academic advisor to discuss this option before the end of their junior year. This is necessary because an undergraduate research project will be expanded to provide the basis for the Master's Degree project.

### **Application Process**

Students must apply for the "5<sup>th</sup> Year Master's Program" through the Graduate School. The standard Graduate School application must be submitted by December 20, and must include two letters of recommendation. One of the letters must be from the research advisor with whom the student intends to work. The Department does NOT require GRE's for admission to this program.

### **Eligibility**

UMass undergraduates in microbiology with a minimum grade point average of 3.0 and a grade point average of 3.0 in all subjects required for the major in Microbiology are eligible for consideration.

### **Program Requirements**

The Graduate School Bulletin provides general information about requirements for Master's Degree candidates.

**Accepted students would begin their graduate work during the summer following completion of their undergraduate degree.** Credit Requirement: 30 credits, distributed as follows:

**A minimum of 21 credits in Microbiology, with a minimum of 12 credits in the 600-800 course series. Students may transfer 1-6 credits of microbiology coursework numbered 500 or higher which they completed as an undergraduate, provided that those credits are**

**NOT used to meet *any undergraduate* requirements for the *University or major*.**

### **Project and Final Exam**

Students are expected to present the results of their research project orally or as a poster presentation. A final **oral exam** is required.

### **Time**

Students are expected to complete the Fifth Year Master's degree in approximately 9 to 12 months. Fifth Year M.S. students are encouraged to work in a lab on their project in the summer, but this may not be a requirement.

For more information, contact Microbiology Graduate Program Director.

## **Pre-Medical and Pre-Dental Information from the Pre-Med Advisors**

### **Selecting a Major**

If you are planning to enter a medical, dental, optometry, osteopathic medical, veterinary or chiropractic school after completing your BS degree, you should select an academic major in the field of your greatest interest and ability. Many UMASS pre-professional students choose a major in **Microbiology**, Biochemistry, Biology, Chemistry, Physics, Psychology, etc. Any major is acceptable as long as it allows the student to complete the minimal pre-professional requirements (see below).

Because of stiff competition for medical school admission, students are strongly advised to select a major that is interesting and challenging to them and allows them the opportunity to pursue a variety of careers. Students preparing for careers in the health professions must be aware of cultural diversity and backgrounds of future patients. Therefore, we encourage students to pursue courses in the liberal arts, humanities and the sciences. Such students are broadly educated and better prepared to make career choices.

Minimum preparation for the pre-professional student must include two semesters each of the following:

Inorganic chemistry, organic chemistry, introductory biology, college mathematics, physics and English. Certain additional courses in biology, microbiology, chemistry, or mathematics may be required or recommended by some medical, dental, or veterinary schools.

### **For More Information and to schedule appointments:**

See CNS Information available at

<http://www.cns.umass.edu/students/pre-medical-and-pre-dental-advising>

## **The Pre-Medical Program**

This program advises all students interested in all areas of medicine and dentistry, and certain other allied health fields. All interested students, regardless of academic major, who are completing their 3<sup>rd</sup> semester at the University (1<sup>st</sup> semester for transfers, special students, continuing education, 2<sup>nd</sup> degree and graduate students) should register at the pre-med office. By registering with the committee, a student can take advantage of advising and counseling from the pre-medical advisors. Letters of recommendation for medical, dental and other professional schools are written by the pre-medical advisors.

A library of medical, dental, optometry, osteopathic, podiatry, chiropractic and veterinary school catalogs and other pertinent materials are available in the Pre-Med Office in Shade Tree Lab.

## **Medical, Dental School Acceptance Rates**

Because we advise such a variety of students, it is difficult to determine accurate and meaningful statistics. Approximately 70% of our applicants gain admission, but this percentage varies greatly by age, and of course, academic and personal records of the students. Residency in a state in which there is a state supported medical school (or schools) is also a definite advantage in gaining admission. Competition for the 100 positions at the sole state medical school in Worcester is keen since over 800 bona fide state residents apply. However, New York has 4 state supported medical schools, so NY residents have a considerably better chance of acceptance at a state school as compared to a MA resident. Similar situations occur with residents of PA, NJ and TX. Please keep this in mind when you inquire about statistics concerning the “admission success rate” for medical school applicants. In the past 10 years it is our experience that successful applicants to any US medical school must have a cumulative grade average of no lower than 3.6 (on a 4.0 scale) and no lower than 30 (~70<sup>th</sup> percentile) on the MCAT along with extensive health/community service. Our acceptance rate for applicants to dental, osteopathy, optometry podiatry and chiropractic schools ranges from 95-100%.

## Course Descriptions

### **MICROBIO 310 General Microbiology** (both sem) 3 credits

A non-majors course which provides an overview of the microbial world including a survey of the structure, functioning, and diversity of microorganisms. Introduction to the fundamental concepts of microbial physiology, ecology, genetics, and pathogenesis. Students must earn a grade of C or higher to progress to upper level Microbiology courses. *Prerequisite:* BIOL 151 and CHEM 261 or concurrent enrollment.

### **MICROBIO 311 Fundamentals of Microbiology** (both sem) 3 credits

A majors' only course which provides foundational skills and knowledge to succeed within the major. Focus will be on microbial structure, genetics, diversity, physiology, and pathogenesis as well as an introduction to the immune system. Students must earn a grade of C or higher to progress to upper level Microbiology courses. *Prerequisite:* BIOL 151 and CHEM 261 or concurrent enrollment.

### **MICROBIO 312 Microbiology Laboratory** (both sem) 3 credits

Microbiological laboratory procedures including sterile technique, microscopy, enrichment and isolation, and preservation. Extensive experience in the cultivation of microorganisms. Covers a variety of topics including bacterial pathogenesis, quorum sensing, antibiotics, biofilms, bacteriophage and fungi. Students must earn a grade of C or higher to progress to upper level Microbiology laboratory courses. *Prerequisite:* MICROBIO 310/311, either previously or concurrently.

### **MICROBIO 320 Infectious Disease and Defense** (Fall sem) 3 credits

This is a sophomore/junior level lecture course designed to provide microbiology and biology majors with a basic understanding of the mechanisms by which microorganisms, including bacteria, protozoa, fungi, and viruses cause disease, and the mechanisms of host defense against infectious microbes. Emerging and reemerging infectious diseases and development of resistance to antimicrobial agents are also discussed. Specifically, students study the innate and adaptive immune responses, cells and organs of the immune system, MHC and HLA systems, the mechanisms of antigen processing and presentation, immune dysfunction, hypersensitivities, autoimmune disorders, principles of vaccine development, HIV/AIDS and the immune system as well as the role of the immune system in cancer development. Students also learn the mechanisms used by various pathogens to evade the immune response. *Prerequisites:* BIOL 151, 152 and MICROBIO 310/311 with grade of C or higher.

### **MICROBIO 330 Microbial Genetics** (Sprg sem) 3 credits

Basic concepts of microbial genetics, and genomics. Both classic and modern experimental approaches to studies of fundamental genetic processes. *Prerequisites:* BIOL 151 and 152 and MICROBIO 311 or MICROBIO 310 with grade of C or higher or ANIMLSCI /BIOCHEM/BIO 285.

### **MICROBIO 360 Writing in Microbiology** (both sem) 3 credits

Satisfies the Junior Year Writing requirement. Students develop their writing skills while completing a series of short assignments. Each participant will identify a biological topic of their choice to research and write about during the semester. This course is generally completed in the fall of the senior year. *Prerequisites:* ENGL WP 112 and MICROBIO 311 or MICROBIO 310 with grade of C or higher.

### **MICROBIO 385 Intro to Biotechnology Laboratory** (Sprg sem) 4 credits

The methodology fundamental to the practice of modern biotechnology is presented. Techniques covered include establishment and manipulation of cell cultures, preparation and analysis of DNA and RNA, production of recombinant protein expression vectors, isolation, purification and characterization of proteins. Major emphasis on the student's performance of laboratory exercises which provide direct experience with each of the techniques mentioned. *Prerequisites:* BIOLOGY 151, BIOLOGY 152 and CHEM 112, or Consent of Instructor.

### **MICROBIO 396 Independent Study** (both sem) 1-6 credits

*Independent Studies* are general research projects arranged individually between students and faculty members. Undergraduates interested in joining a laboratory and participating in the research process should contact individual faculty members to apply to work in the faculty member's laboratory. Generally, students earn three credits for a semester of work. Requirements for Independent Study vary and undergraduates should be sure that they understand the expectations and requirements for the credits they will earn. A Microbiology Course Override Form is required for registration in **Microbiology 396 – Independent Study**. Form available in main Microbiology Office.

### **MICROBIO 398 PRACTICUM** (both sem) 1-18 credits

*Practicum* credits may be earned by undergraduates participating as undergraduate teaching assistants in laboratory and lecture courses. Students interested in being an undergraduate TA should contact the individual instructor for the course. Applications for laboratory TA's are available at registration time in the Main Microbiology Office. A Microbiology Course Override Form is required for registration in **Microbiology 398 – Practicum**.

**MICROBIO 440 Microbial Ecology and Evolution** (Fall sem) 3 credits

An introduction to the evolutionary mechanisms that develop the immense range of microbial life that exists today. This will include an integrative approach to understand the role of microbial life in the evolution and ecology of the biosphere, community dynamics at molecular and organismal levels, and a genomic approach to understand the physiology and ecology of microbial communities. *Prerequisite:* MICROBIO 311 or MICROBIO 310 with grade of C or higher.

**MICROBIO 444 Biodeterioration, Bioconversion, and Bioenergy** (Fall sem) 3 credits

Aspects of natural degradative systems, and how biomimicry of these systems can be harnessed for sustainable energy and product production. A review of biodegradation processes employed by fungal, bacterial, insect, and marine organisms relative to carbon and nutrient cycling, and the production of feedstocks for bioenergy and biomaterials necessary for the development of a sustainable society. *Prerequisite:* Bio 152 and Chem 112

**MICROBIO 450 Outbreaks** (Sprg sem) 3 credits

An examination of the relationships and feedbacks between infectious disease and society, with a focus on the role of race, class, and economic status in the development of epidemics. Topics covered include germ theory, disease history and ecology, microbial pathogenesis and the immune response, historic plagues, and the biological, environmental, population and social changes that contribute to disease emergence. *Prerequisite:* MICROBIO 311 or MICROBIO 310 with grade of C or higher.

**MICROBIO 480 Microbial Physiology & Diversity** (Sprg sem) 3 credits

Essential aspects of bacterial growth, including energy metabolism, macromolecular assemblages and functions, and the integration of metabolic processes by various regulatory mechanisms. Also the diversity of microorganisms, including origins of diversity, ecological and environmental pressures that create diversity, and how to measure diversity with examples from specific environments and microbial assemblages. *Prerequisite:* MICROBIO 311 or MICROBIO 310 with grade of C or higher.

**MICROBIO 494BI, 494CI, 494DI, 494FI, 494MI, 494NI, 494PI, 494QI, 494SI The Integrative Experience** (Both semesters, 1 credit /module; 3 modules required to fill the IE requirement)

The Integrative Experience is a University Requirement. In Microbiology, the IE consists of three 1-credit modules. All Microbiology majors must complete three modules to meet the requirement. The IE will be offered in



both spring and fall semesters. Consult the listing of courses each semester to view specific information about IE offerings.

**MICROBIO 542 Immunology Laboratory** (Fall sem) 3 credits

Students will become familiar with and proficient in the performance of principles and protocols in cellular immunology, immunochemistry and clinical serology. The course examines protein chemistry of antibodies, including antibody isolation using salt precipitation, ion exchange, and molecular sieving column chromatography, spectrophotometry, SDS polyacrylamide gel electrophoresis (PAGE), western blotting, immunoprecipitation, enzyme-linked immunoassay (ELISA), and immunofluorescence staining. Students perform classic serological assays including the complement fixation test, passive hemagglutination and immunodiffusion (Ouchterlony technique). Anatomy of the lymphatic system will be explored using a mouse model. Students perform mouse dissection, lymph node examination, and isolation of lymphocytes from the mouse spleen and thymus. Finally, students are exposed to cellular immunology, including mammalian histology, identification and enumeration of mouse and human leukocytes, normal and diseased lymphoid tissue, and two-color flow cytometric analysis of lymphocyte subpopulations. *Prerequisite or corequisite:* course in immunology e.g., MICROBIO 320 or ANIMLSCI 572.

**MICROBIO 552 Pathogenic Bacteriology Laboratory** (Sprg sem) 3 credits

Laboratory procedures in clinical and diagnostic bacteriology including: i) culture and characteristics of most commonly encountered pathogenic bacteria; ii) recommended procedures for their cultivation and isolation from clinical material; iii) conventional and rapid methods for detection and identification; iv) prescribed tests for the susceptibility of bacteria to antibiotics. *Prerequisite:* Must have completed MICROBIO 312 with a C or higher.

**MICROBIO 562 Environmental Biotechnology** (varies) 3 credits

Microbial Biotechnology is a laboratory course supported by lectures and demonstrations. This advanced course is designed to introduce graduate level students to traditional and molecular methods strategically applied to problems related to microbial biotechnology and environmental microbiology. Course topics cover a wide range of subjects from the diversity of microbial life to biodegradation. Seven general areas are emphasized: (1) Statistical sampling and chemical and physical site characterization, (2) biomass determination and cell counts, (3) enrichment techniques, (4) microbial activity measurements, (5) single cell detection in situ, (6) sequence analysis and phylogenetic analysis followed by probe design, and (7) other modern techniques of environmental

microbiology. *Prerequisites:* Must have completed MICROBIO 312 with a C or higher.

**MICROBIO 565 Laboratory in Molecular Genetics** (Fall sem) 4 credits  
Methodology and principles of modern molecular genetics. Microbial genetics combining classical techniques with bacteriophages and bacteria with modern PCR and recombinant DNA experiments. Introduction to genomic and structural analysis using computer methods. Designed to help students learn techniques and analyze results.

*Prerequisites:* Must have completed MICROBIO 312 with a C or higher. MICROBIO 330 or equivalent.

**MICROBIO 570 Virology** (varies) 3 credits

Molecular biology of animal viruses and viral genetic systems; viral disease processes. Emphasis on polio virus, influenza, herpes viruses, the DNA tumor viruses, retroviruses (including HIV), and hepadna viruses.

*Prerequisite:* MICROBIO 310 or MICROBIO 311; BIOCHEM 420 recommended.

**MICROBIO 582 Parasitology** (Sprg sem) 3 credits

This course is designed to provide students with an understanding of both classical and modern parasitology concentrating on protozoan and worm parasites of major medical/veterinary importance. Topics covered will include basic principles of parasitology, life cycles, epidemiology, host-parasite interactions, drug treatments and vector control programs, along with information on the basic biology, biochemistry and genetics of selected parasites. *Prerequisites:* BIO 151 and BIOCHEM 420,

***Special Topics Vary from Year to Year***

***See Registration Guide for Current Offerings***

# Department of Microbiology Faculty

## **Steven J. Sandler**

### **Professor and Department Head**

B.A., University of Pennsylvania

Ph.D., University of California at Berkeley

My research interests focus on how the processes of DNA replication, DNA repair, Recombination and Cell Division are coordinated at the molecular level. We use the bacterium, *E. coli*, as a model system to explore these areas. This is an important area to study because failure to properly repair one's replication forks can lead to an increase frequency of mutation that in turn can lead to cancer. We employ a large variety of techniques that include: genetics, molecular biological approaches and microscopy with the green fluorescence protein fused to proteins of interest.

## **John Burand**

### **Professor**

B.S. Defiance College

M.S. Miami University

Ph.D., Washington State

The research focus of my lab is on the biology and molecular biology of insect pathogenic viruses, including baculoviruses, nudiviruses and bee viruses. The emphasis of our work is on virus-host interactions that affect the virulence and persistence of these viruses in insects. One virus my research group works on known as HzNV-2 is transmitted by moths during mating and results in the infected insect being sterile. While some aspects of this virus have the potential for use in controlling pest insects, viruses in bees are responsible for causing devastating diseases in these beneficial insects. Our goal is to use what we learn about the biology and molecular biology of these viruses to develop biological control strategies for insect pests as well as to improve the overall health of beneficial insects like bees.

**Kristen M. DeAngelis**

**Assistant Professor**

B.A., Harvard University

Ph.D., University of California Berkeley

The work of my lab involves understanding how microbes cycle carbon in rhizosphere soil, which is the soil environment directly influenced by the root, and applying discoveries of novel enzymes towards improvement of next-generation biofuels. There are tens of thousands of different bacterial species in one gram of soil, in abundance of  $10^{10}$  cells per gram. The abundance, composition and behavior of microbial communities are dynamic, both in response to local events (like a root moving through a pocket of soil, depositing carbon for food) as well as global events (such as increasing temperatures due to climate change). In order to better predict the effects of climate change that are important to us, like changes in soil fertility or greenhouse gas emissions, we need to understand what species are in soil communities, how individual species work together as communities, and how communities respond to local stresses and stimulants. Currently we are testing the hypotheses that (1) as plant-derived labile organic carbon decreases in response to warming, rhizosphere bacteria capable of carbon granule formation and storage have a competitive advantage, and (2) microbes involved in anaerobic decomposition in wet tropical or temperate soils are comprised of bacteria using novel enzymes to break down lignocellulosic carbon. To test these hypotheses, we use a combination of molecular, microbiological and biochemical techniques including 16S rRNA sequencing, stable isotope probing, enzyme assays, and metagenomics.

**Steve Goodwin**

**Professor & Dean, College of Natural Sciences**

B.A., University of Maine, M.S., University of Virginia

Ph.D., University of Wisconsin

**Barry Goodell****Professor**

B.S., University of New Hampshire

M.S., Ph.D., Oregon State University

The Goodell Lab focuses on oxygen radical generation in fungal systems that impact both humans and the environment. Specifically, we explore how fungi initiate pathogenesis in humans through redox cycling of metals under certain conditions. One fungus we study causes Cryptococcal meningitis, which kills 600,000 people each year. Interestingly the natural habitat of this fungus is the bark of forest trees. Understanding the fundamental mechanisms of how this fungus causes pathogenesis helps us as we explore better treatments for disease. We also work with closely related fungi in the environment and study similar mechanisms that these fungi use to degrade biomass in the nature. Some of these fungal mechanisms can be used in biomimetic processes that can potentially be developed into commercial processes to produce sustainable biofuels or renewable chemicals.

**James F. Holden****Professor**

B.S., M.S., Ph.D., University of Washington

My research is on organisms that grow at temperatures above 100°C in deep-sea hydrothermal vents and draws together microbial physiology, microbial ecology and biochemistry. My current research is focused on how autotrophic organisms fix CO<sub>2</sub> and generate energy for growth and how these organisms behave in the presence of other different microorganisms (e.g., competition, mutualism). I have participated in several research cruises to hydrothermal vent sites, which included dives in the deep-sea submarine *Alvin*. My goal is to understand the geomicrobiology of deep-sea hydrothermal environments at life's upper temperature limit. I am also studying the use of moderate thermophiles for use in membrane bioreactors for the treatment of volatile organic compounds in wastewaters generated by local chemical manufacturing industries. The laboratory techniques we use include measuring growth and metabolite production rates, enzyme assays and characterizations, proteomics and bioinformatics.

**Michele M. Klingbeil****Associate Professor**

B.S., M.S., Cleveland State University

Ph.D., University of Toledo

My research focuses on protozoan parasites that cause disease affecting millions of people worldwide. I am especially interested in the unconventional biological properties these pathogens possess which can be exploited as potential drug targets. One property without counterpart in nature is the amazing mitochondrial DNA network of Trypanosomes called kinetoplast DNA (kDNA). The kDNA network is composed of thousands of topologically interlocked circular DNA molecules (minicircles and maxicircles), and replication of the network requires release of individual DNA molecules and their subsequent reattachment. Our work has led to the unprecedented discovery of four mitochondrial DNA polymerases similar to bacterial DNA polymerase I, and by using the genetic tool RNA interference we demonstrated that at least two of these polymerases play a role in kDNA replication. We utilize a combination of biochemical, molecular, cell biological and genetic techniques to decipher the replication and repair machinery required to maintain the kDNA network.

**John M. Lopes****Professor and Associate Dean**

B.A., University of Rhode Island

Ph.D., University of South Carolina

A central process in biology is how genes are turned off (repression) and turned on (activation), a process generally called gene regulation. Understanding this intricate process has occupied biologists for more than four decades. The simple brewer's yeast, *Saccharomyces cerevisiae*, has served as model for studying gene regulation. In part, this is because yeast is a eukaryote that is very similar to other more complex eukaryotes such as humans. But the main advantage of yeast is the combination of tools such as genetics, molecular biology, biochemistry, cell biology, genomics and bioinformatics, that can be mobilized to study a specific biological problem. My lab uses yeast to study the regulation of genes involved in making cellular membranes. The two main regulatory proteins required to activate these genes have been identified and belong to a huge eukaryotic family of proteins called basic helix-loop-helix (bHLH) proteins. The bHLH proteins are known to cooperate with each other to regulate a diverse array of processes including carcinogenesis, development, and cell growth. Yeast have a total nine bHLH proteins. We are currently studying how these nine proteins work together to regulate gene

expression in yeast. The process of repression is far less understood in eukaryotes, consequently, we are also studying how several regulatory proteins repress expression of the yeast membrane biosynthetic genes.

**Derek R. Lovley**

**Distinguished University Professor**

B.A., University of Connecticut

M.A., Clark University

Ph.D., Michigan State University

My research focuses on novel microorganisms that live in environments that lack oxygen. This research has implications for the remediation of contaminated groundwater and sediments, the evolution of life, and life on other planets. Current topics include: the use of microorganisms to remove uranium and other contaminated metals from groundwater; microbial degradation of hydrocarbon contaminants; life in the deep subsurface; the potential for microbial life on Mars; and the use of microorganisms to harvest energy from the environment in the form of electricity. Research on these topics employ modern molecular techniques such as whole genome sequencing, DNA microarrays, proteomics, microbial genetics, and biochemistry. A portion of the laboratory is also involved in implementing the findings of these basic studies in actual remediation projects and other practical applications. This research is supported by the National Science Foundation, the Department of Energy, the Office of Naval Research, the U.S. Geological Survey, and private industry.

**Yasu S. Morita**

**Assistant Professor**

B.A., International Christian University

Ph.D., Johns Hopkins University

Tuberculosis is an infectious disease that kills millions of people annually. It is caused by a bacterium called *Mycobacterium tuberculosis*. BCG vaccine, a live attenuated vaccine, is available, but its efficacy is controversial. Furthermore, no new drugs have been introduced since 1960's, and *M. tuberculosis* strains that are resistant to existing drugs are now widespread. Therefore, introduction of new drugs and effective vaccines are in dire need. My laboratory is interested in uncovering novel drug targets, especially focusing on the biogenesis of cell wall and plasma membrane. Mycobacterial cell wall represents a formidable barrier that is highly lipidic and impermeable to many commonly used antibiotics such as penicillin. Biosyntheses of cell wall components are promising drug

targets, and we are particularly interested in the biosynthetic pathways of phospholipids and glycolipids such as phosphatidylinositol 3-phosphate (PI3P), phosphatidylinositol mannosides (PIMs), lipomannan (LM), and lipoarabinomannan (LAM). Using *M. tuberculosis* as well as non-pathogenic *M. smegmatis*, we are currently investigating (1) spatial and topological regulations of PIM biosynthesis, (2) enzymatic mechanisms of LM/LAM glycan polymerization, (3) potential signaling mechanisms of PI3P, and (4) physiological significance of PIMs/LM/LAM. We use bacteriological, genetic, molecular, cell biological, and biochemical approaches to tackle these issues. Some of our methodologies include targeted gene deletion and other gene manipulation techniques, fluorescent and electron microscopy, and biochemical techniques such as chromatographic analysis of lipids and glycans, ultracentrifugal fractionations of membranes, protein purification and analysis, and cell-free enzyme assays.

## **Mandy Muller**

### **Assistant Professor**

B.S., M.S., Ecole Normale Supérieure (ENS), Lyon, France  
Ph.D., Institut Pasteur, Université Paris VII

The lab's interests lie in understanding how viruses interface with the pathways that govern messenger RNA (mRNA) turnover. The ability to regulate RNA stability has the potential to impact gene expression on a global scale, but is also critical for fine-tuning cellular responses to specific stimuli as well as eliminating flawed and potentially deleterious transcripts. Additionally, eliminating host mRNA is beneficial for viral processes, as it is believed to free up materials to make fresh viral progeny as well as eliminate potentially competitive or antiviral cellular transcripts. We focus on  $\gamma$ -herpesviruses such as Kaposi's sarcoma-associated herpesvirus (KSHV), as these agents promote global cellular mRNA destruction during their lytic replication cycle. This is enacted by a single viral endonuclease called SOX. Although the majority of cellular mRNAs are downregulated during KSHV infection, a subset of mRNAs evade destruction. We are exploring how RNA sequence and structural elements help mediate their protection from SOX, and whether RNP complex remodeling occurs on these escaping transcripts.



## **Klaus Nüsslein**

### **Professor**

B.S., Technical University of Munich

M.S., University of Munich

Ph.D., Michigan State University

My specialty is the ecology of microorganisms and environmental microbiology, i.e., how microbes interact with each other and with their environment. Microbes, just like us organize themselves into communities and interact and work together. In my research I focus on environmental stresses that influence this interaction. For instance, how do microbes stay organized together in surface soil when it rains hard or survive together as a functioning group when it does not rain at all? Since all of our lives depend directly and indirectly on the activity of microbes, my research group also studies how these environmental influences or stresses can have an effect on the functions and activities of a microbial community. Please, come and visit my laboratory web page where you will find a lot more interesting information about microbial ecology and how we research it: <http://www.bio.umass.edu/micro/nusslein>

## **Stephen Rich**

### **Professor**

B.S., St. Lawrence University

M.S., University of Vermont

Ph.D., University of California, Irvine

My laboratory studies zoonotic diseases, diseases that originate and / or are maintained in animal populations. I seek to better understand how the agents of these diseases (microbes) have adapted to making their livelihood at the expense of their hosts (animals and humans). The diseases we study primarily in my lab are vector-borne zoonoses, i.e. those whose transmission is facilitated by a blood feeding arthropod. In particular, we have focused most of our efforts on study of Lyme Borreliosis (Lyme Disease) and human malaria. We are now studying not just the basic biology of these pathogens and their transmission, but also investigating means of intervening. In malaria, we've been working on a whole plant therapy that holds great promise in killing malaria parasites but also shows some resilience to evolving parasite resistance. In the realm of tick-borne diseases, we've engaged a first-of-its-kind passive surveillance for established (eg. Lyme) and emerging (eg. *Anaplasma*, *Babesia*, and *Bartonella*) pathogens in the range of human-biting ticks. From that work we're finding spread of emergent pathogens and that in turn drives our efforts to learn the causes of that spread.

**M. Sloan Siegrist**  
**Assistant Professor**

B.S., Stanford University

Ph.D. Harvard School of Public Health

The cell wall is an essential interface between a bacterium and its surroundings. This dynamic structure accommodates the basic cellular processes of growth and division while protecting against environmental and immune insults. Because it is essential for viability and is composed in part of molecules that are not present in host cells, the bacterial cell wall has been a particularly fruitful target for antibiotic development.

Both the remarkable biology and medical potential of the cell wall have inspired steady research on the topic for over half a century. Indeed, cell wall synthesis and remodeling are well described for model bacteria replicating in broth culture. However, the vast majority of species are unlikely to fit this paradigm neatly. Moreover, these processes have been primarily studied under defined conditions that may or may not recapitulate the natural environment.

Our research focuses on the cell wall of intracellular pathogens such as *Mycobacterium tuberculosis* and *Listeria monocytogenes*. The broad goals of our lab are (1) to determine the mechanisms by which these pathogens adapt their cell wall to the host environment and (2) to engineer the bacterial cell wall for basic and translational biomedical applications. To tackle these challenges, we draw from chemical biology, genetics, biochemistry and biophysics and develop new tools when appropriate.

**Wilmore Webley**  
**Associate Professor**

B.S., Northern Caribbean University  
M.S., Ph.D., University of Massachusetts

Our laboratory is interested in the entry and survival of the obligate intracellular pathogens, the Chlamydiaceae. In particular, we have embarked on a path to elucidate the functions of the host proteins associated with the chlamydial inclusions at entry as well as early and late stages of inclusion development. Additionally, we would like to study the signaling pathways activated at the time of bacterial attachment, entry and inclusion development with the hope of determining the strategies used by Chlamydia to invade and survive in particular host cells. Preliminary data shows that Caveolin and intermediate filament proteins might be involved in inclusion growth and structural stability respectively. We are also interested in understanding the entire range of chlamydial tropism, especially in human infections, with the hope of better understanding the mechanisms of these infections. Lastly, we are also involved in the design and development of display and delivery systems for potential efficacious chlamydial vaccines as well as more reliable diagnostic tests and primary culture techniques. Our approach is a combination of genetics, molecular biology, cell biology and immunology techniques.

## ***Teaching Faculty***

**Erika A. Hamilton**

**Senior Lecturer & Director, Microbiology Teaching Services**

B.A., Mount Holyoke College

Ph.D., University of Massachusetts

**Heather Reed**

**Lecturer**

B.S., University of Georgia

Ph.D., University of Colorado

My interests in microbiology are varied. I was irresistibly drawn into microbiology from initial my interests and academic training in ecology. Of course we live in a microbial world; so inevitably I find that understanding microbes better makes understanding everything else easier. Certainly, an ecological lens makes the exploration of all aspects of microbiology extremely exciting for me. Microbes do run the world.

As the Department's Chief Undergraduate Advisor, I am the primary contact for Microbiology majors. I assist students with academic as well as career planning. I am also available to support students during internships and other academic activities such as study abroad, independent study and practicums.

**Mitchell Walkowicz**

**Lecturer**

B.A., Colby College

Ph.D., University of Tennessee

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## Internet Resources

The following is a list of interesting internet sites focusing on topics in Microbiology and Biotechnology:

<http://www.asm.org>

<http://www.cdc.gov>

<http://www.bio.umass.edu/micro/nusslein/links.html>

<http://www.umass.edu/microbio/chime>

<http://www.apsnet.org/education>

<http://www.elsevier.com/locate/envpol>

<http://www.thescientificworld.com>

<http://extension.umass.edu/agriculture/>

## Information about the Biotechnology Industry:

<http://www.biospace.com>

<http://www.bio.org>

<http://www.massbio.org>

<http://www.biocareer.com>

<http://www.sciencecareers.org>

**Be sure to check out Microbiology's Peer Advising program and the UMass Microbiology Club ([umass.mcu@gmail.com](mailto:umass.mcu@gmail.com)).**

**The Peer Advising office is room 339 in Morrill 1.**

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Massachusetts  
Amherst

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