

Microbiologist

Snapshot

Career Cluster(s): Agriculture, Food & Natural Resources; Health Science; Science, Technology, Engineering & Mathematics

Interests: Science; Microbiology, Biotechnology; Data Analysis

Earnings (Yearly Average): \$84,400

Employment & Outlook: Slower Than Average Growth Expected

OVERVIEW

Sphere of Work

Microbiologists study microorganisms such as bacteria, viruses, algae, fungi, and some types of parasites. They try to understand how these organisms live, grow, and interact with their environments. Microbiologists study microorganisms such as bacteria, viruses, algae, fungi, and some types of parasites.

Work Environment

Microbiologists typically work in laboratories, offices, and industrial settings where they conduct experiments and analyze the results. Microbiologists who work with dangerous organisms must follow strict safety procedures to avoid contamination. Some microbiologists may conduct on-site visits or collect samples from the environment or worksites, and, as a result, may travel occasionally and spend some time outside.

Basic researchers who work in academia usually choose the focus of their research and run their own laboratories. Applied researchers who work for companies study the products that the company will sell or suggest modifications



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to the production process so that the company can become more efficient. Basic researchers often need to fund their research by winning grants. These grants often put pressure on researchers to meet deadlines and other specifications. Research grants are generally awarded through a competitive selection process.

Most microbiologists work full time and keep regular hours.

Occupation Interest

Microbiologists should be innately curious by nature and find satisfaction in investigating microscopic life and broadening the understanding of it. Also, they study the smallest organisms, an area of science that is currently evolving at a fast pace. New and exciting discoveries in the areas of clinical microbiology and biotechnology are common. Microbiologists are sometimes asked by government agencies or private companies and organizations to provide insight into the

spread of germs and disease. Because the applications of microbiology span many areas, there is a wide range of subfields in which microbiologists may choose to specialize.

Duties and Responsibilities

- Planning and conducting complex research projects
- Performing laboratory experiments that are used in the diagnosis and treatment of illnesses
- Supervising the work of biological technicians and other workers and evaluating their results
- Isolating and maintaining cultures of bacteria or other microorganisms for study
- Identifying and classifying microorganisms found in specimens collected from humans, plants, animals, or the environment
- Monitoring the effect of microorganisms on plants, animals, other microorganisms, or the environment
- Reviewing literature and the findings of other researchers and attending conferences
- Preparing technical reports, publishing research papers, and making recommendations based on research findings
- Presenting research findings to scientists, nonscientist executives, engineers, other colleagues, and the public

Profile

Working Conditions: Indoors

Physical Strength: Light Work

Education Needs: Bachelor's Degree; Master's Degree; Doctoral Degree

Licensure/Certification: Typically Not Required

Opportunities for Experience: Internship

Interest Score: IR

A Day in the Life—Duties and Responsibilities

Many microbiologists work in research and development conducting basic research or applied research. The aim of basic research is to increase scientific knowledge. An example is growing strains of bacteria in various conditions to learn how they react to those conditions. Other microbiologists conduct applied research and develop new products to solve particular problems. For example, microbiologists may aid in the development of genetically engineered crops, better biofuels, or new vaccines.

Microbiologists use computers and a wide variety of sophisticated laboratory instruments to do their experiments. Electron microscopes are used to study bacteria, and advanced computer software is used to analyze the growth of microorganisms found in samples.

It is increasingly common for microbiologists to work on teams with technicians and scientists in other fields because many scientific research projects involve multiple disciplines. Microbiologists may collaborate with medical scientists or molecular biologists while researching new drugs, or they may work in medical diagnostic laboratories alongside physicians and nurses to help prevent, treat, and cure diseases.

Many people with a microbiology background become high school teachers or postsecondary teachers.

OCCUPATION SPECIALTIES

Bacteriologist

Bacteriologists study the growth, development, and other properties of bacteria, including the positive and negative effects that bacteria have on plants, animals, and humans.

Clinical Microbiologist

Clinical microbiologists perform a wide range of clinical laboratory tests on specimens collected from plants, humans, and animals to aid in detection of disease. Clinical and medical microbiologists whose work involves directly researching human health may be classified as medical scientists.

Environmental Microbiologist

Environmental microbiologists study how microorganisms interact with the environment and each other. They may study the use of microbes to clean up area contaminated by heavy metals or study how microbes could aid crop growth.

Industrial Microbiologist

Industrial microbiologists study and solve problems related to industrial production processes. They may examine microbial growth found in the pipes of a chemical factory, monitor the impact industrial waste has on the local ecosystem, or oversee the microbial activities used in cheese production to ensure quality.

Mycologist

Mycologists study the properties of fungi such as yeast and mold. They also study the ways fungi can be used to benefit society (for example, in food or the environment) and the risk fungi may pose.

Parasitologist

Parasitologists study the life cycle of parasites, the parasite-host relationship, and how parasites adapt to different environments. They may investigate the outbreak and control of parasitic diseases such as malaria.

Public Health Microbiologist

Public health microbiologists examine specimens to track, control, and prevent communicable diseases and other health hazards. They typically provide laboratory services for local health departments and community health programs.

Virologist

Virologists study the structure, development, and other properties of viruses and any effects viruses have on infected organisms.

WORK ENVIRONMENT

Immediate Physical Environment

Microbiologists spend most of their time in the laboratory, conducting research using a wide array of microscopes and other analytical equipment. These laboratories can be operated by the federal government, public and private universities, or private organizations and foundations. These environments are clean, bright, and well-ventilated. Many microbiologists spend some working hours outdoors collecting samples from water sources, plant life, and other resources. Fieldwork may require travel to remote locations, hiking over rugged terrain, or working in difficult weather conditions. Microbiologists who hold positions at universities and colleges split their time between the classroom, the laboratory, and the office. Microbiologists usually work a regular forty-hour week, with extra hours typically required only when deadlines approach or an emergency occurs.

Because a clean, sterile environment is necessary to ensure the validity of research results, laboratories have strict rules governing personal hygiene, surface cleanliness, clothing, and air quality. Despite these protocols, some microbiologists may experience a slight risk of exposure to dangerous chemicals or germs.

Human Environment

Depending upon their areas of expertise, microbiologists interact and collaborate with a wide range of individuals. Among those with whom microbiologists work are laboratory technicians, lab assistants and interns, environmental scientists, medical doctors and researchers, government officials, and university students and professors.

Technological Environment

Microbiologists use a wide range of tools and technology to complete their work. Their equipment may include electron and light microscopes, sampling tools and equipment, centrifuges, infrared spectrometers, heating blocks, incubators, slides and test tubes, microbiology analyzers, and sterilization equipment. Additionally, they must use medical database systems, analytical software, and general office software (including presentation programs).

EDUCATION, TRAINING, AND ADVANCEMENT

High School/Secondary

High school students who wish to become microbiologists should take biology, chemistry, physics, physiology, and other natural sciences. Computer science training is also helpful, as are mathematics courses like algebra, calculus, and statistics. English and other classes that teach presentation and communication skills are highly useful.

Suggested High School Subjects

- Algebra
- Anatomy
- Biochemistry
- Biology
- Botany
- Calculus
- Chemistry
- Computer Science
- Earth Science
- English
- Environmental Science
- Physics
- Physiology
- Statistics

Related Career Pathways/Majors*Agriculture, Food & Natural Resources**Career Cluster*

- Food Products & Processing Systems Pathway

Health Science Career Cluster

- Biotechnology Research & Development Pathway

*Science, Technology, Engineering &**Mathematics Career Cluster*

- Science & Mathematics Pathway

Postsecondary

A bachelor's degree in microbiology or a closely related field is needed for entry-level microbiologist jobs. A PhD is needed to perform independent research and to work in universities.

Microbiologists need at least a bachelor's degree in microbiology or a closely related program that offers substantial coursework in microbiology, such as biochemistry or cell biology. Many colleges and universities offer degree programs in biological sciences, including microbiology.

Most microbiology majors take core courses in microbial genetics and microbial physiology and elective classes such as environmental microbiology and virology. Students also should take classes in other sciences, such as biochemistry, chemistry, and physics, because it is important for microbiologists to have a broad understanding of the sciences. Courses in statistics, math, and computer science are important for microbiologists because they may need to do complex data analysis.

Microbiologists typically require a PhD to conduct independent research and work in colleges and universities. Graduate students studying microbiology commonly specialize in a subfield such as bacteriology or immunology. Doctoral

Transferable Skills and Abilities**Communication Skills**

- Communicating their research processes and findings effectively so that knowledge may be applied correctly

Detail Oriented

- Conducting scientific experiments and analyses with accuracy and precision

Interpersonal Skills

- Working efficiently with colleagues on research teams toward common goals
- Leading research teams
- Motivating and directing team members

Logical-thinking Skills

- Drawing conclusions from experimental results through sound reasoning and judgment

Math Skills

- Using complex mathematical equations and formulas
- Understanding of math, including calculus and statistics

Observation Skills

- Monitoring experiments constantly
- Keeping a complete, accurate record of work done and noting conditions, procedures, and results

Perseverance

- Staying motivated and focused on work despite substantial trial and error

Problem-solving Skills

- Using scientific experiments and analysis to find solutions to complex scientific problems

Time-management Skills

- Managing time and prioritizing tasks effectively while maintaining quality of work to meet deadlines on research and laboratory tests

programs usually include class work, laboratory research, and completing a thesis or dissertation.

Related College Majors

- Biochemistry, Biophysics, & Molecular Biology
- Biotechnology
- Botany
- Cell Biology & Anatomical Sciences
- Chemistry
- Ecology, Evolution & Systematic Biology
- General Biology
- Genetics
- Immunology
- Molecular Medicine
- Neurobiology & Neurosciences
- Pharmacology & Toxicology
- Physics
- Physiology & Pathology Sciences
- Zoology

Adult Job Seekers

Qualified microbiologists may apply directly to universities and colleges with openings. They may also find employment through university placement offices. Microbiologists who desire employment with state or federal government agencies may respond to postings on agency websites. Joining and networking through professional microbiology associations, such as the American Society for Microbiology (ASM), can be a useful job search strategy.

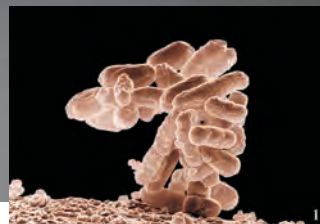
It is important for prospective microbiologists to have laboratory experience before entering the workforce. Most undergraduate microbiology programs include a mandatory laboratory requirement, but additional laboratory coursework is recommended. Students also can gain valuable laboratory experience through internships with prospective employers, such as drug manufacturers.

Professional Certification and Licensure

Many microbiology PhD holders begin their careers in temporary postdoctoral research positions. During their postdoctoral appointment, they collaborate with experienced scientists as they continue to learn about their specialties and develop a broader understanding of related areas of research. Postdoctoral positions

Fast Fact

The human body has ten times more microbes than human cells. Source: medium.com



A cluster of *E. coli* bacteria, magnified 10,000 times. Photo via Wikimedia Commons. [Public domain.]

typically offer the opportunity to publish research findings. A solid record of published research is essential to getting a permanent college or university faculty position.

Additional Requirements

Microbiologists should demonstrate exceptional research and analytical skills and the ability to formulate theories and hypotheses based on a combination of smaller pieces of data. Strong knowledge of medical science is also useful, especially for microbiologists who work in virology, immunology, and similar subfields. Microbiologists must possess strong interpersonal and public speaking skills to collaborate on research and present research results to colleagues. They should be innately curious and find satisfaction in investigating microscopic life and broadening general understanding of it.

Some states have certification requirements for microbiologists working in laboratories. Interested individuals should consult the department of health in the state where they seek employment.

EARNINGS AND ADVANCEMENT

The median annual wage for microbiologists was \$84,400 in 2020. The lowest 10 percent earned less than \$45,690, and the highest 10 percent earned more than \$156,360.

Most microbiologists work full time and keep regular hours. Microbiologists may receive paid vacations, holidays, and sick days; life and health insurance; and retirement benefits. These are usually paid by the employer.

Microbiology is a thriving field that should provide good prospects for qualified workers. Most of the applied research projects that microbiologists are involved in require the expertise of scientists in multiple fields such as geology, chemistry,

and medicine. Microbiologists with some familiarity of other disciplines should have the best opportunities.

Much of basic research depends upon funding from the federal government through the National Institutes of Health (NIH) and the National Science Foundation (NSF). Federal budgetary decisions and private capital availability will affect job prospects in basic research from year to year. There is strong competition among microbiologists for research funding. However, many opportunities for microbiologists are likely to be available.

EMPLOYMENT AND OUTLOOK

Microbiologists held 21,400 jobs in 2020. Employment of microbiologists is projected to grow 5 percent from 2020 to 2030, slower than the average for all occupations.

Microbiologists will be needed to help pharmaceutical and biotechnology companies develop drugs that are produced with the aid of microorganisms. In addition, employers will need microbiologists to ensure quality and production efficiency in a range of companies, including food products and chemical plants.

In agriculture, microbiologists will be needed to help develop genetically engineered crops that provide greater yields or require less pesticide and fertilizer. Finally, efforts to discover new and improved ways to preserve the environment and safeguard public health also will make use of microbiologists.

However, since microbiologists can be heavily involved in research and development (R&D) work, growth in this occupation may be limited by R&D funding constraints.

Related Occupations

- Agricultural/Food Scientist
- Biochemist/Biophysicist
- Biological Technician
- Clinical Laboratory Technologist/Technician
- Conservation Scientist/Forester
- Environmental Scientist/Specialist
- Geoscientist
- Medical Scientist
- Natural Sciences Manager
- Zoologist/Wildlife Biologist

MORE INFORMATION**American Academy of Forensic Sciences (AAFS)**

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American Forensic Association (AFA)

P.O. Box 67021
Chestnut Hill, MA 02467-0001
EricMorris@MissouriState.edu
www.americanforensicsassoc.org

American Institute of Biological Sciences (AIBS)

950 Herndon Parkway, Suite 450
Herndon, VA 20170
703.674.2500
www.aibs.org

American Society for Biochemistry and Molecular Biology (ASBMB)

11200 Rockville Pike, Suite 302
Rockville, MD 20852-3110
240.283.6600
www.asbmb.org

American Society for Microbiology (ASM)

1752 N Street NW
Washington, DC 20036
202.737.3600
service@asmusa.org
asm.org

Biotechnology Innovation Organization (BIO)

1201 Maryland Avenue SW, Suite 900
Washington, DC 20024
202.962.9200
www.bio.org

International Science Council (ISC)

5 Rue Auguste Vacquerie
75116 Paris, France
33.1.45.25.03.29
secretariat@council.science
council.science

International Union of Microbiological Societies (IUMS)

www.iums.org

Society for Industrial Microbiology and Biotechnology (SIMB)

3929 Old Lee Highway, Suite 92A
Fairfax, VA 22030-2421
703.691.3357
www.simbhq.org

Kristina Domizio; updated by Stuart Paterson

Conversation With...

ROBERT F. GARRY, PHD

Professor of Microbiology and Immunology
Tulane School of Medicine, New Orleans, Louisiana
Research scientist, 40 years

What was your individual career path in terms of education/training, entry-level job, or other significant opportunity?

I majored in biology at Indiana State University and had a great experience in a great research lab studying virology. I was encouraged by a graduate student and a postdoctoral researcher who must have seen some potential and took me under their wings. I got fascinated by the field of virology and how you can discover things and make a difference. The possibilities are endless. I enjoyed the camaraderie in the lab. I wouldn't want to be doing anything else.

I received my PhD in microbiology with a focus on virology at the University of Texas in Austin. I remained for my postdoctoral research and worked in an area that was off the beaten track at the time, on a retrovirus, reticuloendotheliosis virus (REV), that can cause immunosuppression in chickens. It turned out to be a fortunate choice because about the time I was finishing my postdoc, a new disease called AIDS appeared. All of a sudden, my work on this obscure avian retrovirus became very relevant because what we were studying—immune suppression—was exactly what we were seeing in AIDS patients.

I received a National Institutes of Health (NIH) grant to study in humans what I had worked on in birds. There just weren't that many people who knew about this. I went on to join an NIH study section, reviewing and funding grants. It's really what happens to move the field forward, and I learned the process of doing science.

I also moved to New Orleans and became an assistant professor, associate professor, and, later, professor at Tulane University.

I worked on AIDS up until 10 or 15 years ago when work on HIV shifted mostly to vaccine discovery, which really isn't my field. This was coincident with 9-11, and concerns about anthrax. Funding shifted as did concern that something like Ebola was a potential bioweapon of mass destruction.

I had worked on tests to determine if people had HIV and learned a lot about the diagnostic industry. NIH was basically looking to fund grants relating to diagnostics, vaccinations, and

therapeutics for these viruses of new concern. So I moved into research on the Lassa virus, a hemorrhagic fever similar to Ebola. Unlike Ebola, which occurs in outbreaks that burn themselves out, Lassa is endemic in West Africa. That means you can study it.

I am principal investigator of the Viral Hemorrhagic Fever Consortium, and set up a lab at Kenema Government Hospital (KGH) in eastern Sierra Leone in 2005. I go four to six times a year for two to three weeks at a time with a team and work with clinicians. In the U.S., we'd be working in a biosafety four-level lab—the high-level labs where you wear a space suit—but there are no rubber suits in Africa. The doctors don't have the opportunity to put on that kind of protection so you have to be pretty brave, as well as the mindset you're going to use as many proper precautions as you can.

In March 2014, the World Health Organization announced the Ebola outbreak in Guinea and Liberia, a three- or four-hour drive from KGH. Lassa and Ebola have similar symptoms, and on May 25, our hospital received its first sample that was positive for Ebola. West Africa is different from the interior of Africa because it is more populated and mining companies—such as those that mine diamonds—have built good roads. People can travel around Sierra Leone, as opposed to a village you could ring off from the spread of disease.

I was at KGH by May 27 with diagnostics and personal protective equipment. The cases kept coming. We were overwhelmed. Kenema had several thousand patients.

Over the past couple of years, we've been able to get back to our Lassa program. But we lost team members to Ebola, including the only virologist in Sierra Leone and the hospital's head nurse. That certainly motivates me to put these diseases behind us.

In addition to my work with the consortium, I am Assistant Dean for Graduate Studies in Biomedical Sciences at Tulane.

What are the most important skills and/or qualities for someone in your profession, particularly someone who decides to work overseas?

Persistence: not being discouraged if an experiment doesn't work the first time, a grant doesn't get funded, or a paper is not accepted.

What do you wish you had known before deciding to work abroad?

I wish I had known about the opportunities for work overseas earlier in my career. Until we got involved in Sierra Leone, my work was laboratory-based. When you see what's happening on the ground, you see what the stakes are.

Are there many job opportunities overseas in your profession? In what specific geographic areas?

Yes, in all developing low- and middle-income countries (LMICs).

Will the willingness of professionals in your career to travel and live overseas change in the next five years?

Yes, I think it will increase. We are seeing more awareness of the need for enhancing basic healthcare infrastructure and for epidemic preparedness.

What role will technology play in those changes, and what skills will be required?

Researchers have to be computer literate, but basic lab skills are a must. So is maturity.

What do you enjoy most about your job? What do you enjoy least about your job?

I most enjoy the eureka moments. I least enjoy paperwork and budgeting.

Can you suggest a valuable “try this” for students considering a career overseas in your profession?

Do work-study or volunteer in a lab. Do a study-abroad program or join the Peace Corps. A research university is probably the most likely place to start if you're interested in going overseas. Public health schools are doing a lot of work in developing countries.

This interview was originally published in 2017.



Conversation With...

HAILEY E. PETERSEN, PHD

Walter Reed Army Institute of Research
Silver Spring, MD
Microbiologist, 6 years

What was your individual career path in terms of education/training, entry-level job, or other significant opportunity?

My AP biology teacher in high school took us into labs and assigned books like *The Hot Zone*. That really got me excited about science and, specifically, microbiology. Infectious disease is interesting, sexy and dangerous. I earned a BS in microbiology from Kansas State University, where I joined a laboratory as an undergraduate assistant. I gained a lot of practical experience and was exposed to lab culture. I also met my first significant mentor, a principal investigator who had other female students in her lab, which attracted me. With her help I decided to get my PhD. Together we navigated the process of asking for recommendations, applying to schools, and the interview process.

During my grad school interviews, what struck me most was being told not to worry so much about what research I was doing but to find a school, a lab, and an advisor I was comfortable with. Don't get me wrong; grad school is intense. But some schools foster a community where students have time for a life of their own. When I visited Tulane University, I knew that was where I needed to be; the people were sincere and the students were hardworking but still happy.

I worked on vaccine development with a bacteria that causes melioidosis, which is like pneumonia. I was drawn to the project because pathogens are classified by how dangerous they are, and this was a level three out of four possible levels. So we wore full suits and worked in a contained, high-security lab.

Entering the last year of my PhD I started exploring my next step. I wanted to do a postdoc but didn't want to be an academic. My ultimate goal is to be head of a lab, but not necessarily at a university. I'm now doing a postdoc at Walter Reed Army Institute of Research, working on vaccine development for shigella, which is a diarrheal disease. The Army is interested because it's an expensive inconvenience for deployed troops and others in the field.

I'm also doing a project management fellowship in the next year, which would be overseeing different projects in a science capacity. For instance, I might share new research that might be applicable to a particular project.

During my search for my postdoc, I did a lot of networking. It can be hard to approach people you don't know, but it was vital to finding my current position.

What are the most important skills and/or qualities for someone in your profession?

You must be persistent. A lot of doing science is failure. Experiments don't work the first time, or the second, or the 50th but you have to keep trying. You read more, you ask questions, you optimize and you try again. You also have to be persistent when it comes to getting funding and publishing. You will submit grants or manuscripts and get rejections and feedback and you need to be able to take that criticism, improve, and try again with a better product.

What do you wish you had known going into this profession?

I've been told that all grad students are miserable and that to really be successful you have to sacrifice personal time. But increasingly, I realize that you can accomplish your goals and do things in a way you are comfortable with if you plan for it.

Are there many job opportunities in your profession? In what specific areas?

Yes. Besides laboratory jobs in academia, industry or government, there are options like being a science writer, a consultant or a patent lawyer.

How do you see your profession changing in the next five years, what role will technology play in those changes, and what skills will be required?

Science is more collaborative than ever and a lot of that is because of technology. The speed of communication makes it easy to work with people all over the world. It has also boosted competition because you want to be the first to publish findings, and if you're not quick, someone may publish before you. You need to be able to build important collaborations with other scientists and communicate your ideas and discoveries clearly and quickly.

What do you enjoy most about your job? What do you enjoy least about your job?

The best part of being a scientist is that you are always on the edge of current knowledge. Every day, you and your colleagues are learning something no one has known before, and that's exciting. You get to tackle amazing questions. What I like least are the small things you must do in order to get to the amazing experiments, such as paperwork, budgeting, and the bureaucracy involved in getting funding or managing a laboratory.

Can you suggest a valuable "try this" for students considering a career in your profession?

Summer internships, laboratory assistantships and lab tech positions are all good ways to get an idea of what it's like in a science lab and what grad school will be like. Most importantly, talk to PhD students and postdocs about their experiences and find an advisor who can help you assess your strengths and weaknesses and help you make the jump to graduate student.

This interview was originally conducted in 2015.