Contemplating career next steps? With years of personal and professional experience, both Across the Divide authors provide insights and wisdom for finding the career right for you.

Shilpa Gadwal
Melanie Sinche

Microbiology can take you in many different directions. Ten individuals below share their microbiology career journeys from cheese making to conservation.

Robert Bowden
Jennifer DeBruyn
Kaitlynn Fenley
Glenn Hatcher
Adam Mumford
Joy Doran-Peterson
Aruna Poojary
Didier Raoult
Elyse Rodgers-Vieira
Nuntra Suwantarat
Catherine Vrentas

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The world around us is ever evolving and becoming more interconnected. We are faced with new global grand challenges, and the need for scientists to interface with decision makers and the public has never been greater. With these changes come new career opportunities.

As a scientific workforce, we are also evolving. We are a heterogeneous group of people with unique perspectives, personalities, abilities, and different drivers that motivate us to put our knowledge and skills to work. Some of us work towards tenure-track positions, driving research that provides the foundation for scientific advancements, but increasingly more of us are choosing nonacademic paths in industry, policy, communication, and technology, to name a few. We now have more options than ever to step out of the mold of an academic track and pursue our passions.

In order to take advantage of the new career options available, we must adapt to the challenges and opportunities that come with an ever evolving career ecosystem. Adaptation to these changes often requires us to acquire new skills and experiences. Seeking advice and assistance from academic institutions, professional science societies, and government agencies is a good start.

The Cultures Careers Issue covers a variety of topics in the arena of career development and career options. The ASM Career Advancement Fellow, Shilpa Gadwal, outlines her career journey from academic research to working in a nonprofit. She explains how she discovered her passion and the lessons she learned along the way. Melanie Sinche, Director of Education at the Jackson Laboratory and author of Next Gen PhD: A Guide to Career Paths in Science, shares her findings on career paths for Ph.D.’s in microbiology, the majority of whom go into nonacademic sectors like startups, nonprofit organizations, research foundations, and federal agencies.

Given that less than 20% of scientists with Ph.D.’s go into tenure-track positions, this issue also showcases career spotlights on individuals with backgrounds in the microbial sciences working in a variety of sectors. From work in IT and bioinformatics, to the necrobiome, the study of the microbes responsible for the decomposition of cadavers, these individuals show us the creativity and breadth of the microbial sciences workforce.

Having taken nonacademic paths ourselves, we learned from our own experiences that scientists can make positive impacts and be successful in their respective careers. ASM provided us with inspiration and support in our journey towards finding careers we are passionate about. Along the way, we discovered that not only did our Ph.D.’s make us experts in our specialized fields, we also gained valuable transferable skills that can be applied to multiple careers.

As you read this issue, we challenge you to reflect on what you want out of your career and the best ways for you to contribute to society. Perhaps you have interests in other scientific disciplines or outside the scientific sphere altogether. We hope this issue encourages you to take active steps to incorporate your interests into a career you are passionate about. If you are yet to find your passion, we hope this issue inspires you to explore and discover.

In the ever changing world we live in, we must continue to challenge ourselves to rethink what drives us as individuals, what it means to be a scientist, and how we can translate our knowledge and experience into a fulfilling career and perhaps discover new passions along the journey.

If you have taken a nonacademic career path and would like to share your story, email careertalk@asmusa.org
Which industry hires the most microbiologists?

Scientific R&D Services

**OTHER TOP INDUSTRIES HIRING MICROBIOLOGISTS:**

- Pharmaceutical & Medicine Manufacturing
- Federal Executive Branch
- Colleges, Universities & Professional Schools
- State Government

6% of all bachelor degrees are in the biological and biomedical sciences.

5,470 microbiologists are employed as Scientific Researchers & Developers.

Is this the right career for you?

Research and development jobs are found in both the private and public sector. From university departments to hospitals to government agencies and industry, scientific R&D allows you to apply your knowledge in a hands-on scientific role to engage in fundamental research and development of scientific ideas. Many scientific R&D roles require a Ph.D.

*SOURCES FROM US DEPT. OF LABOR*  
See More: https://www.bls.gov/oes/current/oes191022.htm
Which industry pays the most for microbiologists?

**Computer Systems Design**

**OTHER TOP PAYING INDUSTRIES:**
- Federal Executive Branch ($104,210)
- Scientific R&D Services ($84,730)
- Management of Companies & Enterprises ($82,080)
- Agricultural Chemical Manufacturing ($81,000)

The average Computer Systems Designer makes: $104,570

Is this the right career for you?

Computer systems design requires an understanding of microbiology as well as computer science. Combining the two allows you to design computer and information systems and provide computer management services to science-specific industries.

- SOURCED FROM US DEPT. OF LABOR
See More: https://www.bls.gov/oes/current/oes191022.htm
Which industry has the highest concentration of microbiologists employed?

Pharmaceutical & Medicine Manufacturing

Other industries with high concentrations of microbiologists:
- Scientific R&D Services
- Soap, Cleaning Compound, and Toilet Preparation Manufacturing
- Federal Executive Branch
- Architectural, Engineering, & Related Services

4.5% of all doctorates are in the biological or biomedical sciences.

21% of microbiologists work in pharmaceutical and medicine manufacturing.

Is this the right career for you?

This industry develops and produces a variety of medicinal and health-related products. A job in this industry may involve manufacturing biological products, processing botanical drugs and herbs, or manufacturing products intended for consumption.
Shilpa Gadwal received her Ph.D. in Microbiology before realizing bench science was not the path for her. As a career fellow at ASM, she shares advice and tips to help you find your career of choice.

Melanie Sinche has built a career around researching and advising postdocs and presents analytical data outlining the future of microbiology.
Leaving research can be difficult, especially if that is what you have done for a long time. After completing my Ph.D. in the Microbiology and Immunology Department at the University of Michigan, I decided to join the American Society for Microbiology (ASM) as the Career Advancement Fellow. I manage and disseminate career advice and programs through our digital and physical platforms. I talk to many trainees about their careers and field a variety of questions from the difference between a CV (curriculum vitae) and a resume, to gaining the right experience for a given career path. I understand there are many challenges to finding your “perfect” career but I can provide you with helpful tips as you explore your career options.
UNDERSTAND YOURSELF.

Be true to who you are and what motivates you when thinking about your career. Everyone has different motivators, skills that they execute well, and unique interests. Discover those factors for yourself and find a career path that aligns closely to those factors.

While completing my Ph.D., I discovered my passion for mentoring other students. This passion was not evident from the beginning of graduate school, but as I reflected on my hobbies, factors that led me to take certain paths in my life, and experiences I felt close to, teaching and mentoring students was a common theme.

EXPLORE YOUR OPTIONS.

Talk to people. Learn about their career paths and understand what excites them. What excites one person may not excite you. Or you might find another person that shares your excitement for a particular career.

Because I only knew about research as a career, I started to explore my options by attending several career panels and doing informational interviews with people – I learned about what they do, how they got into their field, and what the future looks like in that profession. After each meeting, I would journal about what I liked and did not like about each career path. This process helped me learn more about myself and provided me with viable career options based on my interests.
GET EXPERIENCE.

It is never too early to get experience or volunteer for your potential career path. Find, or even create opportunities in your community within your university, and in professional societies that are pertinent to your prospective career field.

After I knew that I wanted to leave research and mentor students on their career, I spent the remainder of graduate school, and thereafter, building experiences in the career development field. On a volunteer basis, I managed career panels, reviewed resumes, presented on job application materials, and provided advice on networking.

BUILD YOUR NETWORK.

Attend networking events, join professional societies, and go to conferences to meet people in your potential field. Convert the people from informational interviews into your network.

Through my experiences, I indirectly built my network. When it came time to apply for jobs, the people in my network were the first to notify me of job openings.
There is no right answer when it comes to finding your career path. Some people find their passion while they are an undergraduate student; others switch career paths later in life. Some people go with whatever opportunities present themselves, while others are more strategic. Finding a career that you are passionate about also requires an understanding that “perfect” does not exist. There are pros and cons with any career, so find a career path where the benefits outweigh the drawbacks and make the opportunity worthwhile. When your career is met with passion, it will seem less like work and more like a hobby.

UNDERSTAND YOUR WORTH.

As someone with a science background, you can offer a lot of professional and technical skills. Learn how to explain them in your resume and interviews with scientists and nonscientists alike.

When I was applying for jobs, I did not know the difference between a CV and resume and had difficulty explaining my transferable skills that I learned in research. I used Versatile Ph.D. and close mentors to help me structure my resume.
Shilpa Gadwal is the Career Advancement Fellow at the American Society for Microbiology (ASM), where she created an online hub for ASM’s career resources and articles, and assessed the career needs of members. She received her B.S. in the Biological Sciences from the University of Maryland, Baltimore County and Ph.D. in Microbiology and Immunology from the University of Michigan, Ann Arbor.
The discussion about how we are training Ph.D.-level scientists, and when – if ever – we are introducing them to career options, continues to be vigorous and ever present, appearing in journals, blogs, Twitter accounts, and news feeds almost daily (see https://chroniclevitae.com/ and http://www.sciencemag.org/careers for examples). Various funding agencies, research institutions, and scientific societies have been examining the structure of graduate education and training in science for more than 25 years now, and the pace has seemed to quicken in the last five.
Will this most recent committee lead to tangible changes for graduate students and postdocs entrenched in the academic system now? Or is Beryl Lieff Benderly correct in her description of the multiple studies conducted over the past 25 years, sitting on an “already-groaning shelf,” as not very likely to contribute to meaningful change?

If you are a current trainee absorbed in your research and unfamiliar with career choices other than the one most readily apparent to you (that of your principal investigator), you may be feeling similarly cynical. In fact, microbiologists currently engaged in postdoctoral research or who have recently completed a Ph.D. or postdoc shared the following sentiments via my survey research, conducted in 2015 under the auspices of the Harvard Labor and Worklife Program:

> “The training I received as a graduate student did very little to prepare me for anything other than a faculty position in a university.”

> “Grad school and postdocs offer few glimpses of jobs outside the conventional professor researcher track, or skills necessary to do such jobs well.”

> “I think that many people going into the advanced life sciences need to have a better picture of what jobs are available and what skills are required for them. The ‘alternative’ careers are now the majority, and people are not being properly prepared for them.”

Yet, as I found in my survey research, where I received over 8,000 responses, the majority of scientists in the United States today – including those in microbiology and related disciplines – are finding satisfying work using skills and experiences developed through their doctoral training and education, despite the imperfections inherent in the current system.
While entering Ph.D. students may have their minds trained on faculty jobs when they complete their training, the vast majority—83%—will enter other professions following the completion of their degree. These professions represent the broad range of options available to microbiologists, such as medical writer, patent agent, or craft brewer. It is critical for you to consider all of the options available to you as you continue with your doctoral or postdoctoral training.
To answer these questions, it is critical for Ph.D.’s in any discipline to develop a better understanding of themselves, their skills, their interests, and their personal values as they relate to working environments. What is most important to you in a job? Is it flexibility in your daily work schedule? Stability in your job over time? A high salary? A particular geographic location? In the survey results, I found that intellectual challenge was rated most important to Ph.D. respondents in regard to why they selected the jobs above. This point is critical in recognizing that intellectual challenges exist in a wide array of career fields beyond the professoriate. Ph.D.’s in microbiology and related disciplines should be aware of the vast assortment of jobs that are stimulating and require skills developed through doctoral and postdoctoral training and education.

However, as these doctoral candidates progressed through their programs, possibly through postdoctoral training, and into careers of interest, this graph changed considerably.

How many microbiologists ended up in tenure-track positions? 18%. In non-tenure-track faculty positions? 9%.

Where did the remaining 73% end up working? The infographic on the previous page indicates the sectors and career fields where microbiology Ph.D.’s have found employment between 1 and 10 years out from their degree.

The diversity of career fields represented here is reflective of the actual job market for Ph.D.’s in microbiology and related fields. The group of microbiologists who completed the survey and are currently employed in the fields above include scientists working in small startups, large nonprofit organizations, research foundations, federal agencies, and universities across the country. These scientists are by and large (75%) using the research skills developed during their Ph.D. training and education, regardless of the actual content of their jobs. My favorite job indicated by a microbiologist in the survey is one who is currently working in quality control at a craft brewery! This scientist is clearly using research skills in his/her assessment of the craft beer on tap.

Exposure to the variety of positions available to Ph.D.’s is part of the equation. A follow-up question for current Ph.D.’s and postdocs in microbiology then remains – how can I find positions similar to these? Has my training prepared me for these positions? Or if we ask a more fundamental question: how can I find a job that is right for me?
“Ph.D.’s in microbiology and related disciplines should be aware of the vast assortment of jobs that are stimulating and require skills developed through doctoral and postdoctoral training and education.”

Once you have spent more time thinking about what’s most important to you in a job, it is essential to engage in career research. What types of jobs exist for Ph.D.’s in microbiology? And using the list above as a potential starting point, what do people in these jobs do? What does regulatory affairs mean, and where do scientists in regulatory affairs work? What about technology transfer? What do employees in this field work on? Where do they work? With whom do they interact on a regular basis? And if you enjoy craft beer, how can you transfer your skills in microbiology to a small craft brewery?

To find answers to these questions, Ph.D. job seekers need to conduct online – and in-person – research. In *Next Gen PhD*, I outline the steps Ph.D.’s can take to find contacts of interest, to build a network in a given field, to approach currently employed Ph.D.’s, to conduct informational interviews, and to narrow down choices and make decisions.

If you would like to begin the important work of career exploration and research, the American Society for Microbiology (ASM) has some of the most robust in-person (at ASM Microbe sessions, June 1–5, 2017, in New Orleans) and online (https://www.asm.org/index.php/learn-about-careers) programs and resources available to learn more about careers in microbiology. You may even be interested in approaching ASM leaders about their own work – did you know, for example, that ASM has an Education Board? An International Board? A Journals Board? A Public and Scientific Affairs Board? A Communications Committee? The ASM represents a microcosm of positions available in the United States for microbiologists. Take advantage of it!

While we can – and perhaps, should – remain optimistic about the most recent spate of national reports and committees focused on systemic change and the career development of Ph.D.’s in science, we must also recognize that every Ph.D. in science has AGENCY. Ph.D.’s and postdocs in microbiology should find multiple mentors; seek out institutional resources; establish a peer support group; connect with professionals on LinkedIn. These and other proactive steps will bring Ph.D.’s closer to finding satisfying work.

And finding career satisfaction beyond the Ph.D. and postdoc is possible. According to my survey results, 80% of Ph.D.’s employed outside a faculty position are happy in their jobs. As with all job seekers, it will take time and effort on the part of every microbiology Ph.D. to find fulfilling work, but it is possible, as evident from the research outlined above. Build a strong network, gain experience, recognize skills you have built through your training, and you will be poised to land a satisfying job.

**REFERENCES**


Melanie Sinche is the Director of Education at The Jackson Laboratory for Genomic Medicine in Farmington, CT. She is also the author of *Next Gen PhD: A Guide to Career Paths in Science*, published by Harvard University Press in 2016. She has served as a Research Associate in the Harvard Labor and Worklife Program, conducting survey research on careers for science Ph.D.’s. She served as the Founding Director of the FAS Office of Postdoctoral Affairs at Harvard University, held the same position at the University of North Carolina at Chapel Hill, and worked with the National Institutes of Health to build the first career center for NIH intramural trainees. She received her Bachelor’s degree from Colgate University and graduate degrees from the University of Michigan and North Carolina State University. She is a National Certified Counselor and is available to speak on careers for graduate students and postdoctoral scholars nationwide.

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The field of microbiology has vast applications, from biofuels to disease research. Hear from microbiologists who work in a diverse set of careers in the microbial sciences.
WHAT INSPIRED YOU TO PURSUE A CAREER IN THE VETERINARY FIELD?

A good mentor. As an undergraduate, I had no knowledge of veterinary microbiology and knew very little about the practice of clinical microbiology. A few days prior to graduation, a professor and mentor of mine emailed to let me know about an opening lab tech position at the university’s veterinary clinical microbiology laboratory. Having strong interests in both pathogenic microbiology and wildlife ecology, I interviewed and landed the position. I was hooked in no time and what I originally thought would serve as a gap-year instead became Plan A.
WHAT IS ONE DIFFERENCE BETWEEN VETERINARY DIAGNOSTICS AND HUMAN DIAGNOSTICS?

Adoption of new technologies is often a slower process on the veterinary side. The majority of costs are paid for out-of-pocket by owners which compels us to keep costs down while still providing good services. I find that it inspires me to keep a close eye on innovations from the human diagnostics side to see how we might adapt them to meet our patients’ needs.

WHAT ADVICE DO YOU HAVE FOR EARLY-CAREER SCIENTISTS LOOKING TO WORK IN VETERINARY MEDICINE?

Having licensure as a veterinarian will certainly afford someone the most opportunities but is not necessarily a requirement for involvement in veterinary microbiology. Many entry-level positions require only bachelor’s-level degrees. Whether you hope to pursue a career in basic research, translational research, or clinical work, veterinary microbiology is a small subset of the microbiology community and the importance of networking can’t be overstated. Face-to-face interactions are the best way to make connections, so try to attend meetings and conferences. Join veterinary-focused organizations and seek out volunteer opportunities. Put in the work to be sure that you have something to offer. I think one of the best ways to do this is to read, read, read. Find the scientific journals in your areas of interest (and tangential areas) and stay up to date, even if all you have access to is abstracts.
My foray into necrobiome research was entirely accidental. I knew from a young age that I would do something related to environmental science – I grew up on a field research station in Northern Ontario, Canada, where my biologist father worked. As an undergraduate, I became fascinated by microbial ecology, and decided to pursue a Ph.D. studying pollutant-degrading microbes. Shortly after starting my faculty position at the University of Tennessee (UT), I had an opportunity to visit the famous UT Anthropology Research Facility (known to some as “The Body Farm”). One faculty member
there started asking me questions about microbial processes related to human decomposition, and I quickly realized how little we knew about the microbes involved in vertebrate mortality decomposition, in general, despite decomposition being a very common process in most ecosystems. Since my research has always been focused on how microbes break down organic compounds (for example, I also work on the microbial degradation of plastics), this just seemed like a natural question for an ecologist to explore!

WHAT ABOUT THIS FIELD MIGHT SURPRISE PEOPLE?

People are usually surprised at just how dynamic and fast vertebrate decomposition is under the right circumstances. In the summers, in East Tennessee, we can go from a fresh body or carcass on the soil surface to a skeleton in as little as two weeks. In one of our feral pig composting trials, after three months of ideal composting conditions, the only thing left of the pig was a bit of hair – not even bones.

Studying vertebrate mortalities may seem a bit esoteric, but there are actually some very important applications of this type of research. For example, because I am at the UT Institute of Agriculture, I work with landowners to develop best practices for livestock mortality composting. There are also applications in the restoration industry, where practitioners are looking for the best way to clean up after unattended deaths; in forensic science, where researchers are pursuing the idea that we could use microbes as trace evidence; and in the funeral industry, where there is increasing demand for more environmentally friendly burial practices that encourage decomposition.

WHAT ADVICE DO YOU HAVE FOR STUDENTS AND POSTDOCS LOOKING TO PURSUE A CAREER IN MICROBIOME RESEARCH?

Microbes are just about everywhere, which means microbiome research can take you almost anywhere. Look for opportunities to network with other scientists outside your discipline; talk to them about their research and learn how microbes may be playing a role in their systems.
My name is Kaitlynn Fenley, and I am living my life through a filter of my passion. I’m a microbiologist, fermented food artisan, lifestyle blogger, and woman business owner. I am a graduate of Louisiana State University and I co-founded Cultured Guru, the first fermented foods company in Louisiana.
WHAT MOTIVATES YOU TO SHARE FERMENTED FOODS WITH THE WORLD AS YOUR CAREER?

As a company and public figures, we are removing the fear of good bacteria in our community through education and by teaching people about the microbiology of fermented foods. Sharing our nutritious probiotic products with the world gives us the opportunity to provide educational information about friendly microbes, the microbiome, and gut health. Helping others to see the world from a microbe-centered perspective, providing more and more people with a means to finally see microbes as allies and a natural, beautiful part of the world, that’s what motivates me.

HOW DID YOU DECIDE TO LEAVE THE TRADITIONAL MICROBIOLOGY FIELD, AND WAS THAT CHALLENGING?

It was one of the most challenging things I’ve ever had to do. I had to decide to either become a clinical microbiologist or take a road less traveled and start a business. I was already running a successful microbiology blog called Microbial Universe with my partner, Scott. We had a choice: to either develop our blog into our dream business or work the 9-to-5 jobs we were getting zero fulfillment from. Long story short, I called my dad for advice. He told me a story about how he knew that he wanted to join the Air Force “when you know, you know.” he said. And that’s when I knew that I knew. Fermented foods, a lifestyle of teaching others to embrace microbes, that is my calling in life.

WHAT LESONS HAVE YOU LEARNED AS A MICROBIOLOGIST COLLABORATING WITH A PHOTOGRAPHER/DESIGNER?

Oh gosh... I’ve learned so many lessons with Scott. Most importantly, with him I’ve learned how to be courageous. How to face my fears and dedicate my life to something that hasn’t been done in this way before. Microbiology lifestyle photography, website, and brand...that’s unique. There is no safety net in this uncharted territory. That takes courage.

WHAT ADVICE DO YOU HAVE FOR SCIENTISTS WITH ENTREPRENEURIAL ASPIRATIONS?

One, you are a sum of the decisions you make. Two, patience is indeed a virtue. Three, NEVER make a decision based solely on money. Four, choose to do something you unconditionally love, something that you are passionate about without bounds. Pick something that you will adore and stay dedicated to even when it disappoints you, keeps you up at night, and frightens you.

“Fermented foods, a lifestyle of teaching others to embrace microbes, that is my calling in life.”
WHAT INSPIRED YOU TO PURSUE A CAREER IN THE CHEESE INDUSTRY?

It was purely happenstance, because my initial career direction was public health. After a brief infectious disease epidemiology position with the U.S. Public Health Service and time spent in the Medical Service branch of the U.S. Army, I landed a bench-top analytical chemistry and microbiology position with Kraft in Chicago. Analytical familiarity with a diverse range of food products eventually led to an R&D position doing new product development with processed cheese products at a large manufacturing facility in Wisconsin. This was my real start in the fascinating industry of cheese production, which remains today as much an art as it is a science. There are well over 2,000 varieties of cheese, and I have tasted less than 300 of them so far!
WHERE DO YOU SEE THE FIELD OF CHEESE MICROBIOLOGY GOING IN THE NEXT 5-10 YEARS?

First, I believe we will see the development of additional adjunct culture strains for cheese making that are specifically intended to impair the ability of pathogens to replicate during cheese manufacture, storage, and distribution. Second, the importance of probiotic bacteria consumption is going to get an additional boost from clinical trial data in support of strain-specific versus generic efficacy.

WHAT ADVICE DO YOU HAVE FOR EARLY-CAREER SCIENTISTS LOOKING TO WORK IN FOOD MICROBIOLOGY?

Be flexible in regard to geographic location and job assignments; maintain the inquisitive mindset that brought you to the discipline in the first place; stay current with new discoveries; surround yourself with individuals who know far more than you do; and, of course, become an NRCM (National Registry of Certified Microbiologists) Food Safety and Quality certified registrant!

“Maintain the inquisitive mindset that brought you to the discipline in the first place.”
MICROBES PLAY AN IMPORTANT ROLE IN BIOREMEDIATION, WHAT LED YOU TO THIS CAREER PATH?

I’ve been fascinated by the potential for bioremediation since learning of the role microbes were playing in hydrocarbon degradation in the aftermath of the Exxon Valdez spill. I’ve been following the thread of bioremediation and biodegradation ever since, starting out as an undergraduate working on microbial trichloroethylene degradation, to a graduate student studying microbial arsenic mobilization, postdoc studying microbial iron corrosion, and now a USGS Mendenhall fellowship looking into how microbial communities interact with oil and gas wastes.
WHAT ADVICE DO YOU HAVE FOR STUDENTS AND POSTDOCS LOOKING TO GET INTO MICROBIAL ECOLOGY

Don’t overspecialize; instead, be flexible and ready to adapt tools and ideas from many different disciplines.

WHAT IS YOUR FAVORITE PART OF YOUR JOB?

My favorite aspect of my job is the opportunity to always be learning something new, and the chance to build new information into our understanding of the role of microbes in the environment. I started out thinking I wanted to do classical microbiology, and work on isolating and characterizing new organisms that did interesting things. While that’s still a part of what I do, I’ve realized that “observing” microbial activity is a lot more than microscopy and serum bottles…and learning new ways to observe is often the most fun part of the process.
Joy Doran-Peterson

Joy Doran-Peterson is a Professor of Microbiology and Director of the Professional Science Master of Biomanufacturing and Bioprocessing at the University of Georgia. She teaches Industrial Microbiology and Biotechnology courses and has an active research laboratory in metabolic pathway engineering and fermentation for a variety of applications.
WHAT SKILLS SHOULD MICROBIOLOGY STUDENTS BE DEVELOPING TO MAKE THEMSELVES COMPETITIVE IN THE WORK FORCE?

In addition to mastering microbiology principles, quantitative skills development in the context of biological problems and applications is very important. Courses in statistics and manipulation of data sets are very valuable for numerous careers. Development of good organizational and communication skills are also crucial. Participation in an industry internship or co-operative learning experience gives a student a feel for a particular career path and lets industry evaluate a future employee. Apprenticeships are serving this same purpose and are becoming more common in some career tracks. It would also benefit students to take advantage of opportunities to conduct independent research projects, present their work at conferences, and publish their findings when possible.

WHAT GAPS DO YOU SEE IN UNDERGRADUATE EDUCATION FOR MICROBIOLOGY STUDENTS?

Participants in the bioeconomy colloquium recognized that we need to take a broader approach in teaching undergraduate microbiology. Ideally, introductory courses would be designed to provide a comprehensive overview of the microbial world. Students should participate in courses on microbial physiology, and diversity and ecology, together with hands-on laboratory experiences. Hearing from a range of microbiologists, each introducing them to career options, would also be desirable. Opportunities for site visits to industry and internships or co-op activities further enhances learning for students.

WHAT LESSONS HAVE YOU DRAWN FROM YOUR OWN CAREER PATH?

Networking is a very important and sometimes an overlooked part of professional development. Taking advantage of opportunities to meet and interact with scientists in all areas of microbiology will greatly enhance career opportunities. The bottom line is that now is an excellent time to be a microbiologist, because scientific understanding and technological tools to put microbes to work continue to advance at an impressive pace. Microbe-powered jobs could help to address many of society's challenges and could provide a lifetime of fulfillment and intellectual stimulation.
Dr. Aruna Ananda Poojary is a Clinical Microbiologist from India. She completed her M.D., D.N.B.(microbiology) in 2006 and A.B.M.M. in 2015. She also completed a Diploma in Hospital Infection Control, Dip(HIC), in the United Kingdom in 2011. She currently works at the Breach Candy Hospital Trust, Mumbai, as a Consultant Microbiologist & Head of Department, in the Department of Pathology & Microbiology. Her interests are in clinical microbiology, hospital infection control, and research in drug resistance.

WHERE DO YOU SEE THE FUTURE OF CLINICAL MICROBIOLOGY AND DIAGNOSTICS?

The future of clinical microbiology and diagnostics is very bright. It’s a field that has something new to offer every day. Conventional methods of identification, drug susceptibility testing, outbreak investigations, etc., are constantly evolving toward new rapid, user-friendly methods. Tests used in research laboratories are now available for daily use in clinical microbiology laboratories. This is an important step toward bridging the gap between diagnostics and management of infectious diseases with shorter turnaround times. Clinical microbiology laboratories will more and more rely upon molecular methods, be it nucleic acids or protein-based methods, to overcome diagnostic challenges. Direct sample identification of diseases of public health significance along with detection of drug resistance mechanisms will be the future of clinical microbiology.
AS A SENIOR CLINICAL MICROBIOLOGIST, YOU PLAY A VITAL ROLE IN HEALTH CARE. WHAT IS THE MOST REWARDING PART OF YOUR JOB?

The most rewarding part of my job is when my advice on microorganisms and the appropriate choice of antibiotic therapy makes a difference in the management of patients suffering from infectious diseases, especially those in the intensive care unit.

WHAT SKILLS SHOULD STUDENTS AND EARLY-CAREER SCIENTISTS DEVELOP IN ORDER TO STUDY OR WORK ABROAD, AND DEVELOP INTERNATIONAL COLLABORATIONS WITH THE INTERNATIONAL SCIENTIFIC COMMUNITY?

Starting early in your undergraduate days is key. Identify topics of interest and reach out to scientists/professors who may be working on these topics. Seek opportunities to be part of such projects, even if it’s just as an observer. Guidance from seniors who may be part of research groups plays an important role. They can also be an important source of information to identify scholarship and internship programs apart from your Internet searches. On a regular basis, discuss topics of mutual interest and new developments in the field with mentors. Learn to prioritize work and develop skills to prepare a workflow sequence when a task has to be completed. Challenges faced when performing a task must be noted down and discussed with colleagues and mentors. Attend meetings, develop an inquisitive mind, and improve networking skills and opportunities. Present your findings at meetings and reach out to others working on similar topics. There are great opportunities in identifying and seeking collaboration with the industry and academia.
CAREER SPOTLIGHT

Didier Raoult

Didier Raoult is a highly cited infectious diseases M.D., Ph.D., with a 146 Google h factor. In 1984, he created ex nihilo his laboratory in Marseille. In 2017, his laboratory transformed into the Fondation “Méditerranée Infection,” a 26,000 m² new building associating care, epidemiology, teaching, and research with 750 staff members.

WHAT MOTIVATES YOU TO STUDY INFECTIOUS DISEASES EVERY DAY?

What motivates me to study infectious diseases is the discovery of something new every day. Microbiology and the study of infectious diseases are rapidly expanding fields, thanks to new technologies that change paradigms. New microbes and new therapeutic strategies can be discovered every day. Here, we find a new bacterial species every day! And every year a new technology allows for a different approach to show unseen aspects of the world of microbiology and infectious diseases. We are in the middle of the widest microbiology revolution.
HOW DID YOU GET INTO PALEOMICROBIOLOGY, WHICH FUSES MICROBIOLOGY WITH EVOLUTION?

For paleomicrobiology, it was by chance that I worked in this field. Marseille is a city that has undergone several major epidemics of plague and cholera. An eighteenth century plague cemetery was discovered in Marseille, and anthropologists asked me to confirm the diagnosis via molecular biology. I had a dentistry student in the laboratory who wanted to do research, so we started using dental pulp to make diagnoses of past diseases. This plague diagnosis had been the subject of much controversy during the last 15 years before everyone recognized it, and forced us to reanalyze the epidemiology of plague and postulate that plague pandemics were due to lice and not to fleas from rats. This was the beginning of a new field, paleomicrobiology. We have tested samples from the Napoleonic era and Louis XIV soldiers, and also 4,000-year-old remains, identifying typhus and trench fever among others.

AS THE MOST CITED MICROBIOLOGIST IN EUROPE, WHAT ADVICE DO YOU HAVE FOR ASPIRING RESEARCHERS?

I recommend to young researchers to have fun every day, to be driven by curiosity. We must find every day the means to be sufficiently motivated. When we succeed in keeping this joy, research is the most beautiful profession in the world and allows us to generate new concepts and new theories. However, research is also tough, and you need to fight for success.
Dr. Elyse Rodgers-Vieira is currently an IT Business Partner supporting Breeding and Trait Development at Bayer. Previously, she was a Scientist in trait discovery at Bayer CropScience working in the areas of molecular biology and bioinformatics, as well as IT project management.

WHAT MOTIVATED YOU TO COMPLETE YOUR ACADEMIC POSTDOC IN ENVIRONMENTAL SCIENCES AND ENGINEERING?

My graduate work was connected with the Superfund Research Program. I wanted to continue working in that area of research because of my strong interest in applying microbiology to help understand environmental issues. The postdoc allowed me to use my background in microbiology and apply it in a different way so that I gained a broader base of knowledge. I enjoyed working in the academic research environment and wanted to expand my skill set while gaining more experience through a postdoc.

Go to https://www.niehs.nih.gov/research/supported/centers/srp/ to learn more about the Superfund Research Program.

Elyse Rodgers-Vieira

Dr. Elyse Rodgers-Vieira is currently an IT Business Partner supporting Breeding and Trait Development at Bayer. Previously, she was a Scientist in trait discovery at Bayer CropScience working in the areas of molecular biology and bioinformatics, as well as IT project management.
WHAT IS THE BEST PART ABOUT YOUR JOB?

The best part of my job is having the opportunity to be part of bringing new technologies and tools to research and the field.

WHY ARE CROP SCIENCE AND GENETICS IMPORTANT FOR OUR FOOD INDUSTRIES?

Crop science research and genetics enable us to develop new technologies to meet the increased need for food and materials. Current consumption patterns and other anticipated changes indicate that we will need to produce more food in the next 50 years than we have in the past 10,000. In addition to crops being a key component of our food supply, they are also required to produce feed and renewable raw materials. Without crop protection, approximately 970 million additional hectares (more than the area of the United States) will be needed to feed our growing population. Research helps us to discover new traits that can enable us to increase crop yield and quality despite growing environmental pressures.

WHAT ADVICE DO YOU HAVE FOR STUDENTS AND EARLY-CAREER MICROBIOLOGISTS?

Stay open to new opportunities both inside and outside the laboratory. Experiences that may differ from your original research or career plan often act as positive catalysts for changes in your career. Seek out leadership opportunities to improve your communication skills and gain experience driving projects and teams. Build your professional network and conduct informational interviews to learn more about possible career paths. Explore different areas of research; many skills you learn are transferable across fields of research, which can open up new employment opportunities.
What inspired you to pursue a career as an infectious disease specialist?

While I was in medical school in Thailand, I found myself drawn to the variety of patients with infectious disease syndromes. I observed that accurate microbiology diagnostics combined with knowledge of infectious diseases led to life-saving treatments. At the University of Hawaii, I was given opportunities to care for patients with interesting diseases such as necrotizing fasciitis, murine typhus, and Lemierre’s disease. As an Infectious Disease (ID) fellow at Case Western Reserve University, knowledge gleaned from daily microbiology rounds along with critical contributions from the ID teams saved the lives of many patients. As a Medical Microbiology Fellow at Johns Hopkins University, I added a new dimension to my infectious diseases training that included both understanding the broad range of diagnostic platforms and laboratory quality management. The investigative work as an ID specialist and microbiologist is fun and challenging, because it allows me to carefully gather data from observation, inquiries, and laboratory tests and to synthesize it all to derive a logical medical plan. This experience has fulfilled my goal to be an excellent ID clinician, microbiologist, and teacher who can inspire my students with enthusiasm and compassion.
WHERE DO YOU SEE THE INFECTIOUS DISEASE FIELD HEADED IN THE NEXT 5-10 YEARS AND HOW CAN STUDENTS AND/OR EARLY-CAREER SCIENTISTS PREPARE FOR CHANGES IN THE FIELD?

Broad ranges of disease spectra make the ID field very challenging and interesting. An ID specialist can work as a clinician, microbiologist, epidemiologist, and/or researcher. Emerging infectious diseases and antimicrobial-resistant pathogens are important medical problems that we will continue to face. Advances in diagnostic microbiology, including broad-based molecular platforms and whole genome sequencing technology, will both challenge us and aid us in earlier diagnosis, and hence better treatment. Students need to have a solid basic foundation of medical knowledge and apply it to clinical practice. Students should, early in their career, define their goals and seek advice from mentors to achieve them.

WHAT ADVICE DO YOU HAVE FOR SCIENTISTS LOOKING TO WORK INTERNATIONALLY?

Globalization has led to the spread of disease more extensively and has created opportunities for international research collaborations. Several organizations such as the WHO, CDC, and Wellcome Trust have worldwide international research sites. ASM also supports this global connection with international events. Moreover, young scientists should investigate what programs already exist at their institutions. Working with compassion and to improve the health of patients who need it most, regardless of where they live, will lead scientists to find opportunities and international collaboration.

“Working with compassion and to improve the health of patients who need it most, regardless of where they live, will lead scientists to find opportunities and international collaboration.”

IMAGE SOURCE
Photo by Thanakrit Sathavornmanee and Chulabhorn International College of Medicine (CICM) students. Microbiology Laboratory, Thammasat University Hospital.
YOU PLAY A VITAL ROLE IN DIAGNOSTICS AND IMPROVED VACCINES FOR BRUCELLOSIS. WHAT IS THE MOST REWARDING PART OF YOUR JOB?

One aspect I really love about working for the U.S. Department of Agriculture is the chance to work in a team-based environment to tackle difficult but very practically relevant issues. Brucellosis impacts both human and animal health across the globe (half a million people are affected each year), and so our research has the potential for future benefits in both areas. I work together with a veterinary pathologist and a veterinary immunologist, as well as a great team of technicians who help with both the molecular and animal work. In this way, we’re able to do experiments that wouldn’t really be possible if I were heading up a laboratory group by myself.
I would tell students not to underestimate the ability of a mentor/advocate to help with difficult hurdles in your career and to help you understand professional norms in your discipline.

TELL US ABOUT YOUR ENGAGED SCIENTIST INITIATIVE.

I’ve been involved in science outreach since graduate school. Tom Zinnen, the Biotechnology Outreach Specialist for Wisconsin-Extension, was my early mentor who encouraged me to start an outreach organization for fellow graduate students. My Engaged Scientist work has been an offshoot of this, with the goal of training and inspiring other scientists to be engaged with the community. Over the years I’ve presented workshops at meetings like American Association for the Advancement of Science, and I’m partnering with colleagues to present a workshop on outreach at ASM Microbe 2017. I was fortunate to receive an ASM Indo-U.S. professorship award this year to present to a class on scientific communication and livestock diseases at Delhi University, India. I see this as the next phase – making international connections around public engagement!

WHAT ADVICE DO YOU HAVE FOR STUDENTS AT ANY LEVEL LOOKING TO PURSUE AN INTEREST IN SCIENCE?

While I know there are plenty of articles about mentoring, I would tell students not to underestimate the ability of a mentor/advocate to help with difficult hurdles in your career and to help you understand professional norms in your discipline – whether it’s reviewing your graduate school personal statement, setting up an informational interview at a company, or even just providing encouragement when you’re frustrated. I saw this first-hand through my experiences at NIH as a postdoc; my time and relationships there helped me to finally get over the hurdle of obtaining a permanent job.
At ASM Microbe 2017?

Attend one of the following Profession of Microbiology track events to jumpstart your career in microbiology.

**Career Talks**
Check out the afternoon career talks in Exhibit Hall D on June 2 - 4.

**Meet the Expert**
Attend a Meet the Expert session on June 3 and June 4 from 7:30 – 8am to learn from experts in a range of fields.

**Up Goer Five Challenge: Microbiology in Plain Language.**
Sunday, June 4 from 5 – 6pm in the POM Track Hub

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**HIGHLIGHTED WORKSHOPS**

**Session 003-WS – Effective and High Impact Scientific Writing**
- June 1, 2017 from 8am – 4pm
- Room 346

**Session 016-WS – Microbiology Career Choices: What’s Available and How to Succeed**
- June 1, 2017 from 12:30 – 4pm
- Room 207

**Session 019-WS – Science Outreach for the Microbiologist: Tips and Tools for Incorporating Outreach into your career**
- June 1, 2016 from 12:30 – 4pm
- Room 253

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Daria Fedorova (@kljgfck), a Moscow-based fine artist, experiments with #silicone and #clay casting, epoxy resin and flat growing on canvases. In some experiments she tries to compare #crystal growth of copper sulfate and #mold on the canvases on a restricted area. Her work is a #modernist visual maze of bacterial and mold structures.

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DO YOU HAVE SOMETHING TO SAY TO CULTURES?

We’d love to hear from you! Was there an article you particularly enjoyed? Or something you want to read more about? Maybe you saw a mistake (hey, we’re human)!
Reach out to us at cultures@asmusa.org.

The views and opinions expressed in this publication are those of the individual authors and do not necessarily represent or reflect the views of the American Society for Microbiology.
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RESOURCES (PAGES 6-11)

1: https://nces.ed.gov/programs/digest/d16/tables/dt16_322.10.asp?current=yes
2: https://nces.ed.gov/programs/digest/d16/tables/dt16_324.10.asp

IMAGE SOURCE (PAGE 62)

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