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Microbiological Anomalies?

Some of our approaches to infectious disease might seem perplexing to a visitor from outer space

Bernard Dixon

If a Martin or Venusian were to visit Earth, then he, she, or it might be puzzled by several aspects of our relationship with microorganisms. Not being familiar with viruses, bacteria, or microfungi back home, but being ferociously intelligent, he, she, or it might, for example, wonder why, decades after the discovery that touch was at least as important as the aerial route in the dissemination of respiratory pathogens, health education remains almost entirely based on coughing and sneezing. The alien might also be perplexed that a global information network, the World Wide Web, purveys accurate, credible advice about infections such as candidiasis and Lyme disease alongside—and with the same prominence as—nonsense.

Our Martian would undoubtedly puzzle over the popularity, in advertising and popular magazines, of photographs of small children cuddling up to and even kissing dogs and cats that are well recognized as disseminators of pathogens such as *Toxocara* and *Campylobacter*. On the other hand, there would be total bewilderment that laboratory and educational rules ensure that students studying known, familiar, harmless, saprophytic microbes recovered from their own skin would have to wear a clean white coat and ensure that their equipment is sterilized afterwards by measures such as autoclaving.

To dramatize the situation, let us imagine a little scenario. The Miles family is spending an evening at home, as driving rain thrashes against the windows and the few fishing craft that have risked the weather make for the safety of the tiny harbor. Grandpa, who handed over as skipper of the family boat to his son just before last Christmas, when he was 85, is telling the two grandchildren, Beth and Joe, about the old days. Beth, as always, is enthralled. But Joe is bored, and starts to pontificate about fishing as a branch of technology. Grandpa’s stories are old hat, he opines. Ripples of banter pass around the family circle. Only when Joe’s callow confidence begins to make the old man splutter with rage does his mother put a firm stop to the conversation by announcing supper.

She and Beth prepare some toast to accompany piping hot soup.

Around 11 PM, everyone begins to feel like bed. Grandpa’s doctor gave him a bottle of medicine for his nasty cough last week and the old man has to be reminded to take some. Joe is going off early tomorrow to visit his uncle, a geologist, and sets an alarm clock accordingly. Mother puts the cat on the doorstep as usual at 11:25, and half an hour later all the members of the Miles family are asleep.

What none of them knows is that during the evening—indeed, sporadically for four months now—Grandpa has been subjecting all around him to an aerosol containing a potentially fatal bacillus. Indeed, the evening’s family circle has been enveloped from time to time by an invisible cloud carrying virulent cells of *Mycobacterium tuberculosis*—just as Michalle Yndak and colleagues described recently in the *Journal of Medical Microbiology* (65:362, 2016).

It was 66 years ago when George Miles, then a young soldier, first encountered *M. tuberculosis*. He knew nothing of it, but the organism was being sprayed liberally around the crowded compartment of a troop train by one of his mates on a long journey back to barracks. Only one of the people unwittingly infected became aware of the fact, when he suffered a massive hemoptysis six months afterwards. Alas, there were no attempts to trace his contacts.

George Miles too was infected. The tubercle bacillus, swept into the depths of a bronchiole, created a sizeable lesion and gave rise to a transient cough some weeks later. Then the body’s defences took over and soon all that remained
was a small calcified scar in the upper lobe of the young soldier’s left lung. The shadow was even recorded on a routine X-ray at a later date. As it was old and healed, however, the lesion was not even notified to his doctor. In any case, reasoned the radiologist who examined the film, there was no point whatever in telling a healthy man that he had once suffered a mild attack of TB—let alone inform him of the remote chance that viable cells of *M. tuberculosis* might remain locked up inside that minute patch of calcified tissue.

Perhaps it was the emotional shock of his wife’s death last October, or a side effect of a prolonged battle with influenza. No one will ever know, but something disturbed George Miles’s oasis of microbial anabiosis towards the end of 2015, opening up a prolific source of airborne pathogens. Beth has already been infected by her grandpa. So has an old friend with whom George regularly has lunch.

Now a second twist on the scenario. Joe is making excellent progress in his studies and, intent on becoming a pathologist, has moved far ahead of his microbiology syllabus at university. It’s four years since he first read Clifford Dobell’s classic book about Antonie van Leeuwenhoek and, modestly equipped for home microscopy, he now enjoys the pursuit described in that affectionate biography, scrutinizing all manner of materials and the animalcules they contain. He has been learning staining techniques and today he does two sorts of tests he’s seen suggested in an old textbook.

First, Joe scoops up some soil from the farmyard across the road, prepares and fixes several slides and treats them with Gram’s stain. Predictably enough, he finds the purple tetanus bacillus in abundance. Then, in the afternoon, he take careful swabs from the hands of various members of the family and tries to identify their resident flora. All show a rich profusion of staphs, gram-negative rods, and lots more besides. Grandpa’s sample is similar, but with acid-fast organisms as well. They couldn’t possibly be tubercle bacilli, Joe decides. They must be those saprophytic mycobacteria that are sometimes confused with pathogenic strains.

The point of my story is a simple one. Joe does meticulous science, wearing rubber gloves to handle soil and finger wipings, sterilizing his loop in a Bunsen flame, and dumping his slides in a jar of antiseptic afterwards. Meanwhile, George Miles has been broadcasting *M. tuberculosis* to all around him, and the farmer owns many acres loaded with *Clostridium tetani*. Curious, isn’t it?
Gates Foundation: “Catalytic Philanthropy” Seeking “Global Health Equity”

Jeffrey L. Fox

“People are willing to have standing armies for war. We need to do something similar for public health,” says Bill Gates, cofounder of the Bill & Melinda Gates Foundation in Seattle, Wash., and former head of Microsoft. He spoke during the opening keynote session, “A Conversation with Bill Gates: Bringing the Frontiers of Science to the Front Lines of Development,” convened at the 2016 ASM Microbe Meeting, held in Boston, Mass., in June.

The Gates Foundation is providing resources for health surveillance and health care delivery in several parts of the world, particularly Africa and Asia, while also supporting a broad array of public health efforts throughout much of the developing world. Although some of this effort is directed to chronic diseases, much of it aims at several key infectious diseases, notably polio and agents such as norovirus that cause diarrheal disease, particularly among children.

In terms of his top four health-related challenges to address in Africa, where needs are great, Gates ranks nutrition and three specific infectious diseases—HIV, malaria, and tuberculosis (TB)—as having high priority. “I hope that we will have approaches for those four in the next 20 years,” he says. Another priority is to fill the infectious disease diagnostic gap in Africa, where the tendency is to “treat all fevers as malaria,” he adds.

Despite these avowed priorities, a major focus for the Gates Foundation during the past few years continues to be polio eradication—a campaign that other organizations launched in 1988 and which now seems close to meeting that goal. “In the last few years, it’s gone well, and we’re now down to two countries with polio, Pakistan and Afghanistan,” Gates says. However, ridding the world of the “last 1% is very hard.” Aside from technical challenges, polio vaccine workers have had to cope with attacks from terrorist groups, including the Taliban, as well as fears in some quarters that the polio vaccine somehow might be dangerous for children. Nonetheless, the goal of eradication seems within reach.

That focused goal is part of a larger, far more ambitious aim of attaining “global health equity,” Gates says. However, he is quick to say that this larger goal requires far more resources than the Gates Foundation can provide directly. Thus, the strategy for meeting this larger goal depends on “catalytic philanthropy”—leveraging the foundation’s resources to set important and far-broader programs in motion. This approach entails working with international and national public health entities, including the World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC) in Atlanta, Ga. They, too, face resource shortfalls as they cooperate to meet these and other challenges. For example, he notes, “There is a huge gap between what WHO is funded to do and what is expected.”

Catalytic philanthropy inevitably requires “tradeoffs” when trying to leverage resources, he says. Under this regimen, if a particular product or strategy being developed “can’t save a life for $1,000, it’s not effective” in the eyes of the foundation. The vaccine-based polio eradication program meets
such criteria and, as an important bonus, has strengthened health delivery systems in dozens of developing countries—thus bringing the more ambitious goal of health equity a bit closer.  

Jeffrey L. Fox is the Microbe Current Topics and Features Editor.

ASM MICROBE 2016

Host-Targeted TB Therapies of Limited Efficacy So Far

Shannon Weiman

*Mycobacterium tuberculosis* (Mtb) is notoriously difficult to eradicate even with combinations of antibiotics, leading researchers to pursue alternate strategies, including one aimed at bolstering host defenses against this pathogen. “Our inability to effectively treat all infected individuals necessitates a deeper understanding of the host-pathogen interface to facilitate new approaches,” says Amy Barczak of the Ragon Institute and Massachusetts General Hospital in Boston, Mass. She was one of several experts who participated in the symposium “Aiming at Non-Conventional Approaches to TB Therapies,” held at the 2016 ASM Microbe Conference in Boston last June.

Mtb exploits innate immunity to its advantage, according to Jeffery Cox of the University of California, Berkeley. Inside host macrophage cells, the pathogen ejects its DNA from phagosomes into the cytosol, where it is misidentified as viral DNA, tricking the host cell into mounting misdirected antiviral responses that favor Mtb survival. Specifically, various immune modulators, including Oasl1 (2’-5’-oligoadenylate synthase-like protein 1), which controls type-1 interferon (IFN) production, are degraded. “We suspect that this primarily antiviral pathway has been co-opted by bacterial pathogens, perhaps primarily to elicit type-1 IFNs,” he says, adding that blocking Oasl1 ubiquitinylations might shift host immunity back toward antibacterial responses.

Mtb also exploits host cytokine signaling, further helping it survive within phagosomes, according to Priscille Brodin of the Institut Pasteur de Lille, France. She is investigating a mechanism by which phagocytosis of Mtb triggers cytokine signaling pathways that ultimately block phagosome acidification. Cancer drugs that target these pathways may thwart Mtb’s survival strategy, promoting phagosome maturation to kill internalized Mtb.

Meanwhile, although a cyclic-di-AMP-dependent cytosolic surveillance mechanism detects Mtb second messengers and activates antibacterial autophagy defenses, Mtb encodes a phosphodiesterase that degrades cyclic-di-AMP, allowing it to fly under the radar, according to William Bishai of Johns Hopkins University in Baltimore, Md. Phosphodiesterase inhibitors, including drugs widely used to treat erectile dysfunction, might give the upper hand back to the immune system, he points out.

Other drugs that promote autophagy defenses and benefit the host include the antidepressant fluoxetine and the cancer drug gefitinib, according to Barczak. “Fluoxetine induces autophagy and enhances production of tumor necrosis factor,” he notes. “Fluoxetine also induces the antiviral defenses and benefits the host include the antidepressant fluoxetine and the cancer drug gefitinib, according to Barczak. “Fluoxetine induces autophagy and enhances production of tumor necrosis factor,” he notes.
factor (TNF)-α,” she says. Similarly, gefitinib, which inhibits epidermal growth factor receptor (EGFR) signaling, enhances autophagy and attenuates Mtb infections in mice, she adds. “During infection, signaling through EGFR activates a p38 MAPK-signaling pathway that prevents macrophages from effectively responding to infection.”

Barczak also uses attenuated Mtb mutants and examines altered cytokine responses to reveal novel mechanisms by which Mtb undermines protective innate immune functions. In doing so, she identified a novel virulence factor required to permeabilize phagosomal membranes and elicit type I IFN responses described by Cox. Blocking such factors would free host immune responses to do their job of controlling infection without pathogen interference.

Although these host-directed therapies show promising results in vitro and in mice, their efficacy is modest compared to antibiotics, making them candidates for adjuvant rather than antibiotic-replacement therapy, says Barczak. They “could play a strategic role in reducing the duration and complexity of treatment while effectively treating drug-resistant strains.” Other complications can arise, adds Bishai. For example, although the antifibrotic drug pirfenidone can effectively disrupt Mtb-containing granulomas in mouse lungs, it undermines antibiotic efficacy and leads to drug resistance.

Shannon Weiman is a freelance writer in Boulder, Colo.

RESEARCH ADVANCES
Evidence of Beer-Making 5,000 Years ago at Site in Shaanxi, China

Carol Potera
Like home brewers today, people living on the Central Plain of China from 3400 to 2900 BCE actively concocted beer in period-appropriate vessels, which archaeologists recently unearthed at Mijiaya near the Chanhe River in Shaanxi province. These artifacts “represent a beer-making toolkit,” and the Mijiya site is the oldest beer-making facility ever discovered in China, according to Jiajing Wang at Stanford University in Stanford, Calif., and her collaborators. This date of about 5,000 years ago for early brewing in China is comparable to estimates for when ancient brewing began further west in Mesopotamia, including reference to the drinking of such beverages that appear in the Old Testament. Details appeared 26 April 2016 in Proceedings of the National Academy of Sciences (doi:10.1073/pnas.1601465113). The pottery funnels, wide-mouth pots, and special jugs uncovered in Shaanxi were used to brew, filter, and store beer, according to Wang. Yellow residues stuck to the interior surfaces of the vessels suggest that they once held beer. Moreover, nearby pottery stoves were likely used to heat ingredients and convert carbohydrates to simpler sugars for typical fermentations, she says.
Further proof comes from an analysis of starches and phytoliths, or fossilized plants, from the site, Wang continues. From 541 starch grains collected from the funnels and pottery shards at the site, researchers identified broomtail and foxtail millet, barley, and Job’s tears, also known as Chinese pearl barley. The presence of barley suggests that this grain arrived in China 1,000 years earlier than previously assumed, and it likely was grown for beer sooner than for food, the researchers suspect. They also discovered evidence for several tubers, including yams, lily, and snake gourd root (Chinese cucumber)—used medicinally today—that might have been used to sweeten and flavor beers being brewed at the site.

Some grains recovered from the site show pits and channels on their surfaces as well as swelling, folds, and distortions. Such patterns match changes that occur to grains during the malting and mashing process, two key steps in beer making. Using ion chromatography, the researchers identified oxalate, another by-product of beer fermentation. “We think this beer was fermented by some wild yeast, but our research methods are not able to detect yeast,” Wang says. As for the flavor and quality of those ancient brews, she adds, “I have no idea. That’s beyond our research methods.”

These findings “indicate that ancient people applied the same principles and techniques as brewers do today,” says Patrick McGovern, an archaeologist at the University of Pennsylvania in Philadelphia, who was not involved in the research at Mijiaya. “The beer was made by malting, mashing, and fermentation.”

Beer production and consumption probably shaped the hierarchical society in the Central Plain of China. For example, “beer likely was involved in some religious rituals or to impress others,” says Wang. Or the ruling class may have rewarded workers with beer. Possibly much of what we consider uniquely human, such as music, dance, religious storytelling, and worship, McGovern adds, “were spurred on by the consumption of alcoholic beverages.”

Carol Potera is a freelance writer in Great Falls, Mont.

RESEARCH ADVANCES

Synthetic DNA for Data Storage—Tantalizing but Pricey, Not yet Practical

Barry E. DiGregorio

Synthetic DNA is looking increasingly promising as a compact means for storing and retrieving different types of data, including text and images, according to Luis Ceze and Georg Seelig at the University of Washington, Doug Carmean and Karin Strauss of Microsoft Research, also in Seattle, and their collaborators. Their approach to exploiting DNA for data storage offers improved “controllable redundancy, reliability, and [information-storage] density” over previous attempts and is one of the first systems that uses DNA molecules to store digital images and retrieve them intact, they say. Details were presented last April in Atlanta during the annual Association for Computing Machinery International Conference on Architectural Support for Programming Languages and Operating Systems (https://homes.cs.washington.edu/luisceze/publications/dnastorage-asplas16.pdf).

The new encoding process allows for random access through a polymerase chain reaction (PCR) that amplifies only the desired data, biasing sequencing towards these data, according to Ceze. “We map digital data into a large collection of 150-nucleotide-long sequences and manufacture the mole-
MINITOPIC

Odds and Ends: Unusual Observations in the Microbial World

Research on microorganisms uncovers fascinating and potentially far-reaching oddities, including:

- Specific guanine-rich stretches—particularly residing in the ribosomal and telomeric gene regions—within the genome of the yeast species *Schizosaccharomyces pombe* contain unusual segments of four-stranded DNA; moreover, the motor protein Pfh1 unfolds these structures, according to Nasim Sabouri at Umeå University in Sweden and his collaborators. Details appeared May 16, 2016 in *Nucleic Acids Research* (doi:10.1093/nar/gkw349).

- Methanogens produce methane gas via an enzyme-catalyzed reaction that unexpectedly makes a highly reactive and unstable methyl radical as an intermediate, according to Stephen Ragsdale of the University of Michigan, Ann Arbor, and his collaborators. Details appeared May 20, 2016 in *Science* (doi:10.1126/science.aaf0616).

- The divisome of *Escherichia coli* bacteria comes apart in a controlled order that closely resembles how it assembles, following a “first-in-first-out principle,” according to Bill Söderström at Okinawa Institute of Science and Technology Graduate University in Okinawa, Japan, and his collaborators. Details appeared May 23, 2016 in *Molecular Microbiology* (doi:10.1111/mmi.13400).

- Sulfate-producing bacteria growing near hydrocarbon seeps produced what tourists who were swimming in the sea near Greece several years ago imagined to be the remains of an ancient city, mistaking natural mineral deposits for submerged paved walkways and stone colonnades, according to Julian Andrews of the University of East Anglia in the United Kingdom and his collaborators. Details appeared June 2, 2016 in *Marine and Petroleum Geology* (doi:10.1016/j.marpetgeo.2016.05.022).

- Instead of relying on their microbiota, stick insects make microbial enzymes themselves—specifically, pectinases for degrading plant cell walls, according to Matan Shelomi at the Max Planck Institute for Chemical Ecology in Jena, Germany, and his collaborators. Details appeared in the May 2016 *Scientific Reports* (doi:10.1038/srep26388).

Barry E. DiGregorio is a freelance writer in Middleport, N.Y.

NEW FROM ASM

A New “Parasitism”: Mitochondrial Genome-Based Hypertension

David C. Holzman

Mothers with a specific mutation in a mitochondrial transfer RNA (tRNA) gene may pass a predisposition to high blood pressure on to their children, according to Min-Xin Guan of Zhejiang
University, Hangzhou, China, and his collaborators. The observation that hypertension within the three families studied appeared to be inherited exclusively maternally led them to suspect mitochondrial involvement, he says. Details appear in the July 2016 Molecular and Cellular Biology (doi:10.1128/MCB.00199–16).

The goal of the investigation was to gain new insights into the pathophysiology of hypertension, says Guan. Mitochondria, which descended long ago from free-living bacteria, live in obligatory symbiosis with eukaryotic cells and still carry much of their own DNA. Although not particularly common and recognized only relatively recently, changes in the mitochondrial genome can lead to major consequences for the host—even seemingly remote host functions such as those of the circulatory system.

“Hypertension is a major global public health problem, affecting approximately 1 billion worldwide”—slightly less than 1 in 8 persons—including 265 million adults in China, and 70 million in the US,” Guan notes. It is a polygenic, multifactorial, and highly heterogeneous disorder, which can be caused by genetics, environmental influences such as diet and stress, and interactions between the two.

After discovering mitochondrial involvement in this newly recognized form of hypertension, the next step was to determine what was malfunctioning in the mitochondria of these hypertensive subjects. “We discovered a mutation on the mitochondrial tRNA-ala gene,” says Guan. That mutation, in turn, reduces cellular production of ATP, the cell’s energy currency, while increasing production of free radicals.

Exactly how these twin biochemical disruptions within mitochondria cause hypertension for the host carrying them is as yet unclear, say Guan and his collaborators. However, they offer a several-step hypothesis to explain how this might occur. Noting an 80% increase in reactive oxygen species in the defective mitochondria, they write that increased reactive oxygen species may damage an array of mitochondrial proteins, nucleic acids, and lipids, “stimulating a forward-feeding loop of mitochondrial reactive oxygen species generation and aggravated cell damage.”

The Chinese researchers further suggest that both the inefficient metabolism stemming from ATP and energy losses and the higher levels of damaging free radicals, as well as a subter imbalance in redox state, could lead to preferential involvement of skeletal and vascular smooth muscles. And that, they write, might cause elevations of systolic blood pressure.

“Data from experimental models of hypertension directly implicate mitochondrial injury in the development and progression of hypertension and target organ injury,” says Lilach O. LeRman of the Mayo Clinic in Rochester, Minn. “Nevertheless, evidence to define the cause-and-effect relationship between hypertension and mitochondrial dysfunction is scant. This paper adds important evidence to suggest a causal link between a novel mitochondrial tRNA mutation and hypertension. As the authors acknowledge, this mutation was unlikely the main cause of hypertension, and probably played a permissive role.”

David C. Holzman is a science writer in Lexington, Mass.

NEW FROM ASM
Viral Structure of
CCD-Associated Virus
Revealed

The crystal structure of the Israeli acute paralysis virus (IAPV) is reported in the Journal of Virology. First author Edukondalu Mullapudi and senior author Pavel Plevka of Masaryk University in Brno, Czech Republic, found that IAPV capsid topology differs from two previously crystallized dicistroviruses, the family to which IAPV also belongs. Although the IAPV structure is similar to vertebrate picornaviruses, the V1 capsid protein of IAPV has no hydrophobic pocket, and thus is unlikely to be inhibited by compounds that inhibit picornaviruses. Future research will focus on finding alternative inhibitors for this virus, associated with colony collapse disorder in United States honeybees.


NEW FROM ASM
Rapid Changes in Vibrio cholerae Population Structure

Collaborators at the University of Alberta in Edmonton, Canada, and Massachussetts Institute of Technology in Cambridge, MA, have found that coastal Vibrio cholerae populations are mainly composed of a small number of clonal complexes, and that the dominant complexes can shift within a matter of weeks. To measure local bacterial populations, Paul Kirchberger, working with lead scientist Yan Boucher, performed sampling and multi-locus sequence analysis from samples of two adjacent bodies of water at two time points separated by three weeks. The bloom-and-collapse cycle suggested by their findings implies a virulent strain could quickly rise to large numbers.

**NEW FROM ASM**

**Boston Subway Full of Harmless Bacteria**

A new mSystems study reports that the Boston transit system is full of bacteria, but the bacteria are not harmful. First author Tiffany Hsu and a scientific team from Harvard University used 16S amplicon and shotgun metagenomic sequencing to find that bacteria from our skin predominate in subways, with Propionibacterium acnes the most abundant bacterial species found across 24 mass transit samples. Little variation was observed between trains or stations serving different demographics, demonstrating that “it’s actually pretty difficult to get a group of bugs to stably transfer from one person to another,” says lead author Curtis Huttenhower.


**NEW FROM ASM**

**Cross-Respiration Increases a Pathogen’s Niche**

A team of scientists from the University of Texas, Austin, have found that mixing a pathogen with a commensal can increase the virulence of the pathogen. Apollo Stacy, working with lead scientist Marvin Whitely, found that Aggregatibacter actinomycetemcomitans (Aa) has an expanded niche when grown in proximity to Streptococcus gordonii. Using transposon sequencing, the scientists found that the presence of S. gordonii shifts Aa metabolism from an anaerobic to aerobic state, possibly by using S. gordonii-generated hydrogen peroxide as an oxygen source, a phenomenon the researchers dub cross-respiration. The discovery illustrates how “we are starting to understand that a lot of modern infections are not caused by single organisms, but by a community of organisms,” says Whitely.


**NEW FROM ASM**

**Small RNAs Regulate Bacteroides Nutrient Use**

Research published in the Journal of Bacteriology demonstrates that a system of small RNAs help regulate the genetic regions called polysaccharide utilization loci (PULs) in the human gut-residing Bacteroides genus. First author Yanlu Cao and senior author C. Jeffrey Smith found that a small antisense RNA (sRNA) gene, donS, regulates activity of the don (for deglycosylation of N-glycans) locus. These sRNAs help the bacterium respond to multiple nutrient sources and may act as a regulatory mechanism to quickly modify gene expression under quickly changing nutrient conditions. The research was a collaboration between East Carolina University in Greenville, NC, and the University of Würzburg in Würzburg, Germany.


**NEW FROM ASM**

**Natural Transformation Identified in Acinetobacter baumannii**

A report in Antimicrobial Agents and Chemotherapy has identified conditions that allow Acinetobacter baumannii, an infectious microbe with increasing isolates, to become competent for transformation. First author German Matias Traglia, working with senior researcher Maria Soledad Ramirez, found that addition of serum albumin and calcium chloride increase natural transformation efficiency by inducing competence-related genes comEA and pilQ. The research, performed at California State University Fullerton in Fullerton, helps explain why antibiotic resistance is also increasing among A. baumannii infections.

Upcoming ASM Meetings

2017 ASM Biothreats: Research, Response, and Policy
February 6–8, 2017 | Washington, DC
Formerly known as the ASM Biodefense and Emerging Infectious Diseases Research Meeting, this premier discusses a wide-range of biological threats and emerging infectious diseases to stimulate knowledge-sharing amongst stakeholders in academia, industry and government; and to help the overlapping communities prepare for, mitigate, and prevent these global threats.

33rd Clinical Virology Symposium
May 7–10, 2017 | Savannah, Georgia
This international symposium delves into the relationship between rapid viral diagnosis, clinical course of viral infections, and preventive and therapeutic modalities for viral infections.

ASM Microbe 2017
June 1–5, 2017 | New Orleans, Louisiana
Integrating ASM’s General Meeting and ICAAC, this unmatched meeting showcases the best microbial sciences in the world, and explores the complete spectrum of microbiology.

Upcoming ASM Conferences

Tentative scheduling of 2017 ASM Conferences is listed below. See the ASM Conferences website for confirmed dates and locations. www.asm.org/conferences

5th ASM Conference on Salmonella
August 29–September 1, 2016 | Potsdam, Germany

6th ASM Conference on Beneficial Microbes
September 9–12, 2016 | Seattle, Washington

ASM Conference on Infection and Cancer
October 24–27, 2016 | Washington, DC

ASM Conference on Antibacterial Development
December 11–14, 2016 | Washington, DC

ASM Conference on Innovative Microbial Ecology for Mitigation of Antibiotic Resistance and Bacterial Diseases
March 2017

ASM Conference on Mechanisms of Interbacterial Cooperation and Competition
March 2017

ASM Conference on Tuberculosis: Past, Present and Future
April 2017

ASM Conference on Interplay of Viral and Bacterial Pathogens (ASM-ASV collaboration)
May 2017

2nd ASM Conference on Rapid Applied Microbial Next-Generation Sequencing and Bioinformatic Pipelines
September 2017

6th ASM Conference on Cell-Cell Communication in Bacteria
October 2017

ASM Conference on Vibrio2017: The Biology of Vibrios
November 2017

4th ASM Conference on Viral Manipulation of Nuclear Processes
December 2017
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Moselio Schaechter, San Diego State University

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Beating the Odds: the Journey of an African-American Microbiologist

From de facto apartheid as a youth to a productive career in research, focused on microbiology and immunology

Howard M. Johnson

I am an internationally recognized immunologist and microbiologist, who has had the good fortune to contribute significantly to research within my discipline. Before I could do so, I had to escape the confines of the American version of an apartheid system, into which I was born in 1936, near Annapolis, Md. This part of the country was then unabashedly racist and remained so throughout the years of my primary and secondary schooling.

Although difficult for me, living in this part of the country was, if anything, far more difficult for my immediate ancestors. Consider, for example, my paternal great-grandfather, Joseph Johnson, who was born in 1850. He escaped slavery as a teenager by jumping ship in nearby Chesapeake Bay. My very existence can be linked to his bold act. As a little boy, I attended Grandpap’s funeral, who lived to 95. I am thus connected personally to a relative who moved from slavery to freedom during the Civil War era.

Early Education: Principles and Important Lessons

The elementary school that I attended was a rural, two-room frame building, which sat on cinder blocks and lacked running water and central heating. By contrast, white kids who lived nearby were bused to schools in Annapolis that were palatial compared to our barebones facilities. I had only two teachers throughout those elementary school years, and they both helped me appreciate the power of knowledge.

One incident during second grade stands out. My teacher, Mrs. Minor, sent me on an errand to a local store. I gave the clerk a dollar bill and received a handful of change, which I did not bother to count, along with the item I bought. I gave them both to Mrs. Minor, who informed me that the clerk had short-changed me by a nickel. She did not punish me but, instead, emphasized that an important principle was involved—more important than the missing nickel. Her message to this seven-year-old was that he had better start using his brain. I never forgot that lesson.

As an elementary student I was aware of, but not obsessed with, the unfairness of having poorer school facilities than white students. For one thing, the poor condition of our school reflected our standard of living. I was in my teens before our house had running water and central heating. My father worked as a laborer at the Naval Academy and my mother as a domestic in the Annapolis area. I am lucky to have had parents with vision, commitment, and an instinct for the importance of education who, despite their modest incomes, managed to set aside enough money to pay for a substantial part of my undergraduate education as well as that of my two brothers.

High School: Improvements with a Catch

After elementary school, I attended Bates High School, which was a physical improvement over...
our two-room primary school in that it was much larger and had running water, restrooms, and central heating. Even so, there was a catch. Bates was in Annapolis, and it was the only black high school in Anne Arundel County, which extends to the edges of both Washington, D.C., and Baltimore, covering a distance of approximately 25 to 30 miles in each direction. Those two cities are about 35 miles apart. One can visualize a triangle connecting Annapolis, Washington, and Baltimore. So, how did Maryland deal with the logistics of providing a single high school for roughly 1,500 black kids spread all over Anne Arundel County? Busing!

From seventh grade through twelfth grade, I spent approximately two hours a day on a bus. Kids at the far reaches of the county spent even longer times between home and school. By comparison, white kids had high schools in several other parts of the county in addition to Annapolis High School, which was much larger and plusher than was Bates High.

When I entered secondary school, I became increasingly aware of inequities in Maryland’s commitment to educating young African-American students compared to their white counterparts. In that period I developed a passion for science that was nurtured by my teachers and admired by my classmates.

For example, my high school was invited to choose a nominee to be interviewed for a possible scholarship to Johns Hopkins University in Baltimore. The scholarship was sponsored by a chemical company. Bates nominated me. My mother took a day off from work without pay to accompany me by bus to Baltimore for the interview. We arrived on time. I sat in an outer office for several hours through lunch time without access to food, drink, or a restroom, while my mother waited outside on the street.

After many hours, I was ushered into some executive’s office. Instead of my being interviewed as a candidate for the scholarship, I was instead admonished for being there at all and sent packing. What was I thinking? Neither Johns Hopkins nor the University of Maryland accepted black students during that era.

Our apartheid system of education sometimes led me to experience such humiliating incidents—incidents that went well beyond the usual run-of-the-mill foolishness that my classmates and I faced every day. Despite these unfortunate incidents, however, my studies in high school left me feeling well-educated and confident of my ability to succeed in college, any college.

College: a Move from De Facto Apartheid

In those days, graduates of Bates High School continued their education at colleges and universities whose students were predominantly or exclusively African-American. Even a superficial
comparison of white universities with their African-American counterparts in Maryland shows sharp differences in resources, with the white schools much more richly endowed than their African-American counterpart institutions of higher education. At that point in my life, I had my fill of this social schizophrenia, and thus decided to apply to a white university outside Maryland.

This move turned out to be the most significant educational decision I ever made, because it propelled me into the white academic and intellectual world where I remained throughout my career. After reviewing catalogues from several schools, I applied to Ohio State University, which accepted me without a problem. During freshman orientation, however, I discovered that about 5,900 of my 6,000 freshman classmates were white.

Nonetheless, I thrived in the competitive and somewhat impersonal environment at Ohio State and graduated in 1958 with a B.S. in microbiology. By that time, I had six or seven close African-American friends on campus. We stayed in the same dorm, had the same disciplined study habits, and did well in our studies. We viewed our achievements not so much as African-American students but simply as students at Ohio State.

Graduate School and a Budding Interest in Research

After completing my B.S., I chose to stay at Ohio State for graduate school in microbiology instead of going to medical school. Following graduation in 1962 with a Ph.D. in microbiology with an emphasis on immunology, I did a year of post-doctoral work at Ohio State. However, when I tried to find an academic position, I was singularly unsuccessful.

Soon, I accepted a research post with the Food and Drug Administration in Cincinnati. In addition to performing my assigned tasks, I developed a research program, pursuing curiosities that attracted my interest. For instance, I was among the first researchers to show that staphylococcal enterotoxins, which are a common source of food poisoning, are T lymphocyte mitogens that exert profound effects on the immune system. I was also one of the first researchers to study and demonstrate the key role of host-produced antiviral proteins, called interferons, as potent immune regulators. The interferon studies were initiated in collaboration with Sam Baron, an expert on the antiviral properties of interferons, at the National Institutes of Health (NIH). Baron was a virologist and was thus interested in the antiviral properties of interferons. My suggestion that we collaborate
to study possible immunological properties of interferons opened a new avenue of immunology research for me.

Baron left NIH to chair the Department of Microbiology at the University of Texas Medical Branch in Galveston, and, in 1975, invited me to join the department as an associate professor. Three years later I was promoted to full professor with tenure. As time passed, my program grew but so did personal tension between Baron and me. In 1983, I accepted a visiting professorship at the University of Florida in Gainesville and became a full professor there in 1984.

Steve Russell, chair of the Pathology Department in the School of Veterinary Medicine in Gainesville, worked with a large phagocytic cell called a macrophage. These cells can be activated to destroy microbially infected cells and cancer cells. He wondered if the activator of these cells was an interferon (IFN) called gamma interferon (IFNγ). I had pioneered IFNγ and was considered to be one of the world’s experts at that time, so the invitation was to collaborate on determining whether the macrophage activation factor was IFNγ. We showed that IFNγ was indeed macrophage activation factor. In 1989 I was promoted from professor to graduate research professor, a form of endowed chair.

**Research Interests Shift, with a Focus on Interferons and Enterotoxins**

The discoveries that my colleagues and I made during the early 1970s with IFN and the staphylococcal enterotoxins had little immediate impact on the immunology and microbiology communities. However, research by others about four years later showing how IFN can upregulate major histocompatibility complex antigens and activate natural killer cell activity intensified interest in IFN as members of this class of molecules were recognized for being more than mere antiviral proteins. Today, IFNs are seen as key cytokines of the immune system.

Similarly, it took time before the enterotoxin superantigens were recognized as being major players—superantigens that activate T lymphocytes. In the 1980s, we showed that staphylococcal enterotoxins act as emetics because they induce T cells to release cytokines such as interleukin 2. We later showed that these superantigens exacerbate autoimmune diseases such as experimental autoimmune encephalomyelitis (EAE) in mice, which models multiple sclerosis in humans. Because staphylococcal enterotoxin is responsible for almost 50% of foodborne outbreaks, its possible involvement in autoimmune diseases deserves careful scrutiny.

Around 1980, investigators realized that IFNβ significantly reduces the symptoms of relapsing-remitting multiple sclerosis. Meanwhile, Ed Blalock and I determined that it and other type-I IFNs induce suppressor T lymphocytes and regulatory cytokines, explaining the therapeutic effects of IFNβ in patients with multiple sclerosis.

In the 1990s, researchers in my lab began studying IFN signaling. Such signaling involves tyrosine Janus kinases (JAKs) as well as signal transducer and activator of transcription (STAT) factors. The beauty of JAK-STAT signaling is its seeming simplicity. Classically, JAK-activated STATs in the nucleus of a cell were considered responsible for activating specific genes. However, because many ligands, growth factors, and hormones use the same STAT transcription factors but exert different functions at different levels, we know this classical view has shortcomings that suggest unrecognized complexities.

**Another Research Interest: Complexities of IFN Signaling**

Our studies thus led to a more complex model of IFN signaling, one that resembles steroid hormone/steroid receptor signaling. Both types I and II IFN signaling involve nuclear translocation of complexed ligands, receptors, activated JAKs, and activated STATs to the promoters of the genes that the IFNs specifically activate.

Moreover, in both cases, such signaling leads to specific gene activation and epigenetic remodeling. Receptor intracellular domains play an important role in binding the C-terminus of the IFNs, which led to our development of IFN mimetics. The mimetics are effective against a broad range of viruses but lack the toxicity associated with intact IFNs. Type I IFN mimetics also protect against EAE in mice without the toxic side effects associated with high-dose IFNs. These findings also provide insights into the specificity of cytokine signaling as well as that of other molecules that use the JAK-STAT pathway.

Prem Subramaniam, a postdoctoral fellow in my lab, and I, working with Ed Blalock from Galveston, identified a small peptide that blocks JAK2 activity by targeting the 13-residue JAK2
activation loop. This tyrosine kinase inhibitory peptide or Tkip inhibits JAK2 as well as IFNγ, according to Lawrence Flowers, a graduate student in my lab.

Tkip has significant homology with several members of the suppressor of cytokine signaling (SOCS) family, which are inducible intracellular regulatory proteins. Tkip shows specific homology with a functional domain, called the kinase inhibitory region (KIR), on SOCS1 and SOCS3 that inhibits the JAK2 tyrosine. Another graduate student of mine, Lilian Waiboci from Kenya, showed that SOCS1-KIR binds to the activation loop of JAK2 and inhibits JAK2 phosphorylation of STAT1α, a transcription factor that is similar to Tkip. When mice cells take up SOCS1-KIR, it is potently therapeutic for EAE.

Another peptide, pJAK2 (1001–1013), which corresponds to the activation loop of JAK2, is a SOCS1 antagonist, according to Waiboci. This antagonist enhances innate and adaptive immune responses of mice against a broad range of viruses, she finds. Our SOCS mimetics and antagonists are thus potential therapeutics that work by negatively and positively regulating the host immune system.

Perspective
I think it is highly improbable that a young black kid who was subjected to an apartheid background and who was raised by a family of very modest means would achieve the scientific successes that came my way. This same kid knew his paternal great grandfather, who was born a slave and then escaped to freedom during the Civil War.

According to the theory of six degrees of separation, everyone is connected to anyone else by six or fewer other individuals. My lab is a miniature United Nations in terms of its diversity of race, religion, and origin. It’s cool that all those who passed through my lab are connected to Grandpap by a mere one degree of separation.

Howard M. Johnson is Professor Emeritus in the Department of Microbiology and Cell Science, University of Florida, Gainesville.

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Fermented Foods, *Lactobacillus*, and Health

*Lactobacillus* bacteria serve as a gateway for understanding transitory host-microbe interactions in the digestive tract

Maria L. Marco and Benjamin L. Golomb

The earliest development of fermented foods, among the most ancient agricultural products, coincided with the rise of civilizations around the world. According to archeological records, wine was produced during the Neolithic Period from 8500 to 4000 BC, while beer and bread were mass-produced shortly thereafter. These foods, as well as others such as cheese, yogurt, and miso, are mentioned in ancient texts, including the Bible, the *Iliad*, and the *Odyssey*. Although modern preservation and processing methods reduced reliance on these products, fermented foods and beverages remain an important part of diets throughout the world.

In the United States, there is renewed interest in fermented foods for both their artisanal manufacture and their capacity to benefit human health. New companies are popping up to produce a wide range of fermented foods and beverages, including pickles, sauerkraut, sourdough bread, artisanal cheeses, yogurts and kefir, craft beers, and kombucha (fermented tea). These foods are not only popular, but they are also considered healthy. Indeed, in the absence of scientifically confirmed health benefits for most fermented foods, consumers are being told that some are “probiotic” and “prebiotic.” Many of these claims revolve around *Lactobacillus* species, which are widely used to ferment foods, and the role that these bacteria play as probiotics.

*Lactobacillus* and closely related lactic acid bacteria (LAB) are the most abundant bacteria consumed within regular US diets, with an individual consumer eating between $10^6$ to $10^9$ living bacterial cells from various fresh and fermented food sources each day. Adding probiotic *Lactobacillus* strains to that mix would provide an opportunity for increasing those numbers considerably. However, the study of host-microbe interactions of ingested probiotic bacteria in the intestine is a relatively new field, much in line with efforts to understand how the indigenous gut microbiome influences its host. Because *Lactobacillus* species are generally regarded as safe for consumption and do not permanently colonize the intestine, studying these bacteria serves as a gateway for investigating transitory host-microbe interactions in the digestive tract. Ultimately, doing so will help us to appreciate not only the microbes on our bodies but also those that join us at the dinner table.

The Microbiota of Fermented Foods

The production of fermented foods and beverages requires a variety of bacteria, molds, and yeasts. Depending on which foods are being fermented and under what conditions, different types of microorganisms tend to proliferate. Because of their metabolic and enzymatic activities, these different microorganisms are mainly responsible for the taste, texture, and aroma properties of the final fermented products.

Fermentations can be relatively simple, involving only one or two microbial species such as for yogurt or relatively complex, requiring both bacterial and fungal populations, sometimes

**SUMMARY**

- Fermented foods and beverages, among the most ancient agricultural products, remain an important part of diets throughout the world.
- Although lactic acid bacteria (LAB) may dominate, production of fermented foods and beverages depends on a variety of bacteria, molds, and yeasts.
- Beyond their direct importance in fermentations, LAB alter foods in ways that benefit human health.
- Probiotics work through three broad mechanisms in the human digestive tract: modifying the indigenous microbiota, stimulating the immune system, and interacting with the epithelium.
- Multiple factors influence *Lactobacillus*-host interactions within the gastrointestinal tract.
growing simultaneously, or in other cases, as with cocoa, in succession. Recent studies using high-throughput DNA sequencing and other methods show that even “simple” fermentations can involve multiple microbial lineages, contain resident bacteriophages that regulate community composition, undergo elaborate microbial cross-feeding networks, and constitute dynamic habitats in which members may compete to succeed one another.

However, even with this breadth of starting materials, processing approaches, and microbial community structures, most fermented foods depend on LAB, which are saccharolytic members of the **Firmicutes** phylum that produce lactic acid and other organic acids as the primary end-products of fermentative growth. LAB genera found in foods include **Lactobacillus**, **Leuconostoc**, **Lactococcus**, **Pediococcus**, **Weisella**, **Oenococcus**, and **Carnobacterium**, with **Lactobacillus** being the most common.

**Lactobacillus** species are essential agents for making a variety of plant, dairy, meat, and beverage products (Fig. 1). Currently, there are 217 recognized species of **Lactobacillus**, and the most well-known food-associated species include **L. plantarum**, **L. casei**, **L. brevis**, **L. rhamnosus**, and **L. delbrueckii**. A recent genome sequencing effort focusing on **Lactobacillus** and other LAB species identified more than 44,000 gene families. The number of gene families increased with each genome sequence, indicating that the genetic potential has not been completely uncovered for this genus.

Diversity within the **Lactobacillus** genus reflects the assortment of environments from which these species are found. In addition to fermenting foods, **Lactobacillus** colonizes human and animal digestive tracts. Side-by-side with **Bi-**

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**Figure 1**

Popular fermented Western foods involving LAB. LAB are essential for a wide variety of fermented dairy, plant, meat, and beverage products. A representative LAB species responsible for each fermentation type is shown below the finished product.
**Health Benefits of Fermented Foods**

Beyond their direct importance in fermentations, LAB alter foods in ways that benefit human health. For one thing, these bacteria metabolize sugars that are not well tolerated by some human populations. Further, they make organic acids and antimicrobial peptides that serve as barriers to the growth of spoilage and pathogenic bacteria. LAB fermentations also produce compounds such as folic acid or other B vitamins and conjugated linoleic acid that benefit consumers.

More recently, experts and consumers increasingly recognize that eating fermented foods may help to prevent a variety of chronic diseases. For example, the regular eating of fermented dairy products is associated with a significantly decreased risk for developing cardiovascular disease and type II diabetes mellitus. Consuming kimchi, a plant-based fermented food that is a staple in the diet of many Koreans, leads to an increase in insulin sensitivity and glucose tolerance in prediabetic adults.

While some fermented foods are pasteurized, roasted, or baked before being consumed, others, such as kimchi and fermented dairy products, serve as a source of living bacteria. These freshly eaten fermented foods can contain over $10^{10}$ LAB cells per serving, some of which survive transit through the gastrointestinal tract. While such food-associated LAB might support human health, the functionality of LAB in the digestive tract is better understood from studies of probiotic *Lactobacillus* strains.
Probiotic Lactobacillus

The World Health Organization defines a probiotic as a living microorganism that, when consumed in sufficient amounts, confers a health benefit on its host. The term probiotic typically is reserved for specific strains investigated in clinical studies. However, this definition can also encompass bacteria in yogurts that reduce lactose concentrations to levels that are acceptable to lactose-intolerant individuals.

Lactobacillus, in particular, are the most widely used and best-understood bacteria applied as probiotics for maintaining and improving human health. Some strains of Lactobacillus are effective at preventing and treating antibiotic-associated diarrhea and acute infectious diarrhea, alleviating lactose intolerance, reducing the risk for necrotizing enterocolitis in infants, and preventing pouchitis, a form of inflammatory bowel disease. Preclinical studies suggest that Lactobacillus might also be useful for preventing metabolic syndrome, reducing anxiety and depression, reducing atopic disease, and preventing bacterial vaginosis. Although the lactobacilli commonly applied as probiotics are typically different from those responsible for fermenting foods, studies of probiotic strains can help to explain how dietary LAB might improve conditions within the digestive tract as well as systemic health.

Probiotics work through three broad mechanisms in the human digestive tract: modification of the indigenous microbiota composition or function, stimulation of the immune system, and interaction with the epithelium. Beyond these general functional categories, there remains the
need to study the precise effectors made by probiotics and corresponding host pathways that respond to them. Thus far, the main Lactobacillus probiotic effectors are cell surface-associated and secreted proteins as well as small metabolites and polysaccharides. Several of these effectors were shown to bind to receptors on intestinal cells to modify cell turnover, tight junction protein localization, and immune response pathways.

**Factors Affecting Probiotic Lactobacillus**

Various external factors influence Lactobacillus-host interactions within the gastrointestinal tract (Fig. 2). We are interested in understanding how LAB such as Lactobacillus adapt to and behave in foods and the digestive tract.

For example, dairy products are a natural habitat for certain LAB and a common means for delivering probiotic Lactobacillus in foods. When cells of L. casei are in milk, we find that proteins for modifying cell surfaces, metabolizing fatty acids, transporting and metabolizing amino acids, and transport of inorganic ions are abundant (Fig. 3). We find that these milk-associated proteins enable L. casei to survive in milk also help cells from this strain to persist in the murine intestine. Remarkably, ingesting L. casei in milk improves its capacity to reduce inflammatory responses. Such delivery vehicle-dependent differences in probiotic efficacy might apply to the behavior of Lactobacillus when delivered to human populations in fermented dairy products. Other LAB are more commonly consumed in

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**Marina Marco**

Maria Marco’s grandmother made pickles, introducing her granddaughter early to food microbiology. “I always thought it was rather mystical how she took the cucumbers from her garden and changed them into pickles,” Marco recalls. “It was only later that I learned that she was fermenting them.”

Marco’s research focus is on lactic acid bacteria (LAB) at University of California (UC) Davis, where she is an Associate Professor in the Department of Food Science and Technology. She and her collaborators investigate the ecology and molecular genetics of LAB, which are essential for fermenting foods. The practical applications of her work, she says, “are many and include improved and new fermented food sensory qualities and extending shelf-life,” as well as “improved methods for delivery of probiotic Lactobacillus to ensure efficacy.”

Marco, 43, the oldest of three children, grew up in Leechburg, Pa., a small coal mining-steel mill town near Pittsburgh. Her father was in the insurance business, her mother a music teacher. They encouraged her “to do many different types of activities ranging from science camps, gymnastics, competitive dancing, art lessons, softball, and concert, marching, and jazz band,” she says. “I really benefited from the exposure to so many different academic and extracurricular activities. I certainly grew up with the impression that I could do anything I set my mind to.”

Her high school science teachers had a lasting impact on her career choice, Marco says. “I knew I wanted to study biology because of my excellent science teachers in high school. In college, I refined this view and was excited when I found microbiology and learned about the far-reaching impacts of microbes.” She earned her B.S. in microbiology in 1995 from the University of Pennsylvania, and her Ph.D., also in microbiology, in 2002 from UC Berkeley. While an undergraduate, she studied in Australia, calling that “a transformative time,” she says. “I’m the only one in my family to have moved away from Pennsylvania. For this reason and my love of science, I’m the ‘black sheep.’”

Marco is married to Johan Leveau, Associate Professor of plant pathology at UC Davis, whom she met at Berkeley. Together they moved to the Netherlands, where she started working on LAB and probiotics. “The more I learned about this group of bacteria, the more I appreciated my grandmother, whose pickle recipes were never written down but rather passed down based on tradition.” She did postdoctoral research there from 2002–2005, and between 2006 and 2008 she worked as a project manager at NIZO food research in Ede, and from 2007–2008 as a project leader at Ti Food & Nutrition in nearby Wageningen. That year, she moved to UC Davis, and was promoted in 2015 to associate professor.

Marco and her husband have two sons, 9 and 12. In her spare time, she enjoys staying active but typically is a “soccer mom” on the weekends. The family also goes “camping and backpacking a few times a year,” she says. “The great thing... is that there is no cell phone service [and] it forces us to put down our devices and be in the moment.”

**Marlene Cimons**

Marlene Cimons lives and writes in Bethesda, Md.
fermented plant foods. To measure how they adapt for growth on plant tissues, we studied *Lactococcus lactis*, another LAB commonly found in fermented foods. Transcript and metabolite levels of *L. lactis* after growth in a leaf tissue lysate of *Arabidopsis thaliana* showed that this LAB metabolizes sucrose, fructose, arabinose, ribose, cellobiose, and hemicellulose (Fig. 3). Cells of *L. lactis* growing in this plant tissue lysate also express genes encoding enzymes involved in oxidative stress pathways and for modifying cell envelope composition. Among these plant-inducible genes is a hybrid nonribosomal protein synthetase/polyketide synthase system. Such systems are responsible for producing secondary metabolites such as siderophores that can confer highly specific, plant-dependent traits, and in the case of *L. lactis* synthesize a molecule involved in reactive oxygen species tolerance, according to our preliminary results.

Once ingested, cells of LAB encounter new conditions that influence their behavior. Lactobacilli are metabolically active in the intestine, expressing genes that depend on intestinal location and the health status of the host. For example, when residing in the ileum of rhesus macaques, *L. plantarum* actively express genes encoding enzymes for degrading host-derived glycans such as sialic acid. This behavior appears to be conserved among other bacteria within the small intestine because the metatranscriptomes of the indigenous bacteria were also enriched with transcripts for fucose, aminosugars, and sialic acid metabolism pathways (Fig. 3).

In contrast, cells of *L. plantarum* respond differently when they are within the distal intestine.

Maria L. Marco is an Associate Professor in the Department of Food Science and Technology, University of California, Davis, and Benjamin L. Golomb received his Ph.D. in 2016 and currently is a Scientist at Bayer Crop Science, West Sacramento, Calif.  

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ASM at the USA Science and Engineering Festival

More than 350,000 visitors, 3,000 hands-on exhibits, 40 ASM member volunteers, and 1 ASM exhibit added up to another successful USA Science and Engineering Festival for ASM. Once again, ASM put together a compelling exhibit to draw visitors into the world of microbes. Visitors learned about the good and the bad side of the microbes on and around us, observed live face mites, chatted with ASM members about the microbial sciences, and took "cell-fies" with a gigantic Giant Microbe. ASM staff and volunteers developed the exhibit to highlight how microbes interact with their hosts. Visitors were drawn into the exhibit by live microscope images of face mites. “What Microbe Are You” matched the visitors’ personality with the “personality” of common residents of the human microbiome. “Pathogen Plinko” focused on behaviors that could influence the outcome of our interactions with microbes. Selecting the best behaviors increased the visitor’s chances of winning a Giant Microbe. Finally, visitors could take a “cell-fie” with gigantic Giant Microbes to remember their visit. While at the exhibit, visitors had the opportunity to engage with ASM member volunteers to ask questions and more deeply explore the microbial sciences. These volunteers really made the exhibit a success. One visitor shared her thoughts: “A great deal of credit goes to the way the booth staff interacted with the people—especially the kids. One booth person really drew my daughter in, literally and figuratively, and did a great job delivering the message and talking with her. The quiz they had for visitors was interesting, fast, and informative.”

It is not too early to start planning for 2018. Share your exhibit ideas with ASM and let us know about opportunities in your area and how we can help you share the microbial sciences with your community.
ASM Public Affairs

ASM Supports Antibiotic Incentive Amendment to the National Defense Authorization Act

ASM has signed a letter supporting an amendment on antibiotic development to the National Defense Authorization Act (NDAA) which would facilitate development of antibiotics to treat serious infections. This report highlights the importance of antibiotic development. The amendment would establish a new limited-population antibacterial drug (LPAD) approval pathway for antibiotics to treat serious or life-threatening infections for which there exists an unmet medical need. To read the letter, go to http://www.asm.org/images/PSAB/NDAA-PathLetter-6-7-16.pdf.

ASM Participates in FDA Network of Experts Open House

ASM joined other members of the Food and Drug Administration (FDA) Network of Experts in an open house on May 25. Addressing the group was Jeffrey Shuren, Director of the FDA Center for Devices and Radiological Health (CDRH). The Network of Experts is a vetted network of outside scientists, clinicians, and engineers who provide the CDRH staff with rapid access to scientific, engineering, and medical expertise when it is needed to supplement existing knowledge and expertise. To read more about this program and to see the list of members, go to http://www.fda.gov/AboutFDA/CentersOfﬁces/OfﬁceofMedicalProductsandTobacco/CDRH/ucm289534.htm.

ASM Attends Briefing on Antibiotic Research and Development

On June 9, ASM staff attended a briefing entitled “The Need for Antibiotic Research and Development” with Lord Jim O’Neill, held by the Infectious Disease Society of America (IDSA) and the Pew Charitable Trusts. Lord O’Neill was commissioned by the U.K. Prime Minister to examine the public health and economic challenges posed by antibiotic resistance and chair the Review on Antimicrobial Resistance, whose report is available at http://amr-review.org/sites/default/files/160518_Final%20Paper_with%20Cover.pdf. Also addressing the briefing was Representative Mike Thompson (CA), who cosponsored the Reinvigorating Antibiotic and Diagnostic Innovation Act of 2015 (READI Act), legislation which would provide tax credits for antibiotic and diagnostic test development.

ASM and APHL Comment on the Upcoming 5th Edition of BMBL

On May 25, ASM and the Association of Public Health Laboratories (APHL) provided comments to the Steering Committee and Editorial Board Members of Biosafety in Microbiological and Biomedical Laboratories (BMBL). Prior to these comments, ASM participated in the May 12 workshop, “Soliciting Stakeholder Input for a Revision of Biosafety in Microbiological and Biomedical Laboratories (BMBL), 5th Edition.” To see the comments, please go to http://www.asm.org/images/PSAB/APHL-ASM-BMBL.pdf.

ASM and PASCV Produce a Zika Guidance Document

On May 10, the ASM Committee on Laboratory Practices, in collaboration with the Pan American Society for Clinical Virology (PASCV) Advocacy and Public Relations Committee, authored “Zika virus: An Update on the Disease and Guidance for Laboratory Testing” to inform the clinical laboratory community about current tests and information on Zika virus disease. To read the document, go to http://www.asm.org/images/PSAB/ZikaGuidance.pdf.

ASM Selects Congressional Science Fellow for 2015-2016

The American Society for Microbiology has awarded the ASM Congressional Science Fellowship to Laura E. Lasiter for 2016–2017. Laura will work on the staff of a member of Congress or congressional committee during her fellowship year.

Laura earned her Ph.D. in Biomedical Sciences at the University of Tennessee Health Science Center in Memphis, Tennessee. She currently works in the lab of Richard Webby at St. Jude Children’s Research Hospital. Her doctorate focused on the zoonotic potential of a novel bovine influenza virus and has contributed to discussions of classification as a new genus. During her tenure at the University of Tennessee, Laura was very active advocating for the importance of the life sciences and academic biomedical research as the Campus Representative for an organization called wewillnotgiveup.org. Laura is excited about communicating her knowledge of science on the Capitol Hill, “With the government’s heightened focus on antibiotic resistance and concerns from the Ebola and Zika virus outbreaks, it is essential to have individuals with science experience in congressional offices,” she said. “The direct impact of science policy on my own career has impressed on me the necessity of scientists in the federal government to influence policy, advocate for the scientific community and pave the way for others to do the same.”

ASM has supported Congressional Fellows since 1977. The ASM Congressional Science Fellowship Selection Committee selects a postdoctoral to mid-career microbiologist to spend one year on the staff of an individual member of Congress, congressional...
committee, or with some other appropriate organizational unit of Congress. Prospective Fellows must be citizens of the United States, members of ASM for at least one year and must have completed their Ph.D. by the time the fellowship begins in September. The Congressional Science Fellowship is supported in part by the Frobisher Fund, a bequest made to ASM by Martin Frobisher. Contact the Office of Public Affairs at publicaffairs@asmusa.org for more information on the ASM fellowship or go to the ASM web page for a program description: http://www.asm.org/index.php/congressional-science-fellowship. The deadline for applications for the 2017–2018 fellowship is February 17, 2017.

**ASM Meetings**

**Watch Session Recordings from ASM Microbe 2016**

ASM Microbe 2016 was jam-packed with informative sessions. Gain access to audio-synced slides from the event throughout the year. You can either purchase the Track Package at $209 per track, or the Full Package at $449. Session recordings do not include the workshop program, and participation of all speakers is subject to their approval. Get your package today at www.asmeventsonline.com.

**Save the Date: ASM Microbe 2017**

Mark your calendar for ASM Microbe 2017 (June 1–5, New Orleans, La.)—the premier event in the field that features cutting-edge science, world-class speakers, abundant networking opportunities, and much more. Don’t miss the rare opportunity to explore the full scope of microbiology by choosing from more than 200 engaging sessions and workshops and over 3,000 posters at this unique event. For more information, visit www.asm.org/meetings.

**ASM Biothreats Conference: Research, Response and Policy**

Formerly known as the ASM Biodefense and Emerging Diseases Research Meeting, the 2017 ASM Biothreats meeting discusses a wide range of biological threats and emerging infectious diseases to stimulate knowledge sharing among stakeholders in academic, industry, and government and to help the overlapping communities prepare for, mitigate, and prevent these global threats. Learn more at www.asm.org/biothreats.

**Mark Your Calendar: 2017 Clinical Virology Symposium**

Join more than 1,000 peers from across the globe at the 33rd annual Clinical Virology Symposium (May 7–10 in Savannah, Ga.). This international symposium delves into the relationship between rapid viral diagnosis, clinical course of viral infections, and preventive and therapeutic modalities for viral infections. For more information, visit www.asm.org/meetings.

**Upcoming ASM Conferences**

ASM Conferences address the needs of the diverse scientific interests of microbiologists by providing a forum for international groups of scientists to discuss their specific area of concentration. Mark your calendar for these upcoming ASM Conferences. For more information, visit www.asm.org/conferences.

- **5th ASM Conference on Salmonella** (August 29–September 1, 2016, Potsdam, Germany)
- **6th ASM Conference on Beneficial Microbes** (September 9–12, 2016, Seattle, WA)
- **ASM Conference on Infection and Cancer** (October 24–27, 2016, Washington, DC)
- **ASM Conference on Antibacterial Development** (December 11–14, 2016, Washington, DC)

Tentative scheduling of 2017 ASM Conferences is listed below. For confirmed dates and locations, visit www.asm.org/conferences.

- **ASM Conference on Innovative Microbial Ecology for Mitigation of Antibiotic Resistance and Bacterial Diseases** (March 2017)
- **ASM Conference on Mechanisms of Intercellular Cooperation and Competition** (March 2017)
- **ASM Conference on Tuberculosis: Past, Present and Future** (April 2017)
- **ASM Conference on Interplay of Viral and Bacterial Pathogens** (ASM-ASV collaboration) (May 2017)
- **2nd ASM Conference on Rapid Applied Microbial Next-Generation Sequencing and Bioinformatic Pipelines** (September 2017)
- **6th ASM Conference on Cell-Cell Communication in Bacteria** (October 2017)
- **4th ASM Conference on Viral Manipulation of Nuclear Processes** (December 2017)

**Education Board**

**ABRCMS 2016**

Registration is open for the Annual Biomedical Research Conference for Minority Students (ABRCMS), set for November 9–12 in Tampa, Fla. As one of the nation’s premier conferences for undergraduates, ABRCMS is dedicated to guiding students in pursuit of advanced training in the biomedical and behavioral sciences, including science, technology, engineering, and mathematics.

While the ABRCMS focus is on supporting undergraduates, the conference is also attended by postbaccalaureates, graduate students, postdoctoral scientists, faculty, and administrators. All participants value the meeting’s lineup of information-rich workshops, scientific presentations, professional development opportunities, networking events, and more. At ABRCMS
2016, several eminent speakers will present on research topics focusing on regenerative engineering, public health, neurobiology and computer science and share insights on their career trajectory. Confirmed plenary lecturers include:

Juan E. Gilbert, Ph.D., Andrew Banks Family Preeminence Endowed Professor and Chair of the Computer & Information Science & Engineering Department at the University of Florida. Gilbert was recently named one of the 50 most important African-Americans in Technology.

Julie Gerberding, M.D., M.P.H., Executive Vice President, Strategic Communications, Global Public Policy, and Population Health at Merck. In her six years as the first woman director of the Centers for Disease Control and Prevention (CDC), Gerberding guided the nation’s leading health protection agency through an era of rapid growth, globalization and innovative transformation.

The HeLa Panel will feature the family of Henrietta Lacks and members of the National Institutes of Health (NIH). An update will be given to the 2013 NIH-Lacks family agreement that enabled controlled-access to HeLa whole-genome sequence data via the NIH database of Genotypes and Phenotypes, while respecting the Lacks family’s privacy.

Stefano Bertuzzi, Ph.D., M.P.H., Chief Executive Officer of ASM. Bertuzzi is responsible for implementing the society’s vision to promote and advance the microbial sciences. He has authored numerous research publications in neurobiology and science policy, which have been published in top scientific journals.

Cato T. Laurencin, M.D., Ph.D., Albert and Wilda Van Dusen Distinguished Endowed Professor of Orthopaedic Surgery and University Professor at the University of Connecticut. A renowned physician-scientist, he is a pioneer in the area of Regenerative Engineering.

Wes Moore, M.S., New York Times best-selling author and Chief Executive Officer of BridgeEdU. Moore is a decorated Army combat veteran and youth advocate. As the CEO of BridgeEdU, he leads a national initiative focusing on addressing the college completion and career placement crisis by reinventing the freshman year of college. He is also the author of two instant New York Times best-selling books, The Other Wes Moore and The Work.

Students (undergraduates and post-baccalaureates) are invited to submit abstracts and travel award applications for the conference. Deadline is 26 August for ABRCMS Student Travel Awards and 9 September for ABRCMS Student Abstract submissions.

For submission criteria, registration information, or program and speaker updates, visit http://bit.ly/abr16nl. ABRCMS is managed by ASM and supported by the National Institute of General Medical Sciences of the National Institutes of Health under award number T36GM073777.

ASM Grant Writing Course (GWC) Online: Grantsmanship for Early-Career Researchers

In response to a growing need for guidance and support on grant applications, ASM has expanded the former ASM Kadner Institute into a two-part comprehensive training program for early-career scientists, including graduate students, postdoctoral fellows, and junior faculty. The first part of the program, the Grant Writing Course (GWC) Online series, was held as a six-part webinar series in March-June 2016. Forty-six individuals (17 graduate students, 17 postdoctoral fellows, and 12 early-career scientists/junior faculty) participated in the series, which offered a practical introduction to grant writing, the federal funding landscape, and grant reviewing processes for the National Science Foundation (NSF) and National Institutes of Health (NIH).

Sponsored by the ASM Committee on Graduate and Postdoctoral Education with support from the ASM Education Board and the ASM-NSF Leaders Inspiring Networks and Knowledge (LINK) program, the 2016 course was co-led by Cynthia Nau Cornelissen of Virginia Commonwealth University and Alvin Holder of Old Dominion University. The series also featured several content experts, who were selected for their successful history as grant writers and reviewers. Each speaker gave didactic, webinar presentations to allow participants to enhance their grant writing skills. Topics and speakers included:

- Michael Ibba (Ohio State University), “Overview of the Grant Making Enterprise and Overall Funding Landscape”
- Eric Skaar (Vanderbilt University), “Writing your NIH Grant”
- Emina Stojkovic (Northeastern Illinois University), “Writing your NSF Grant”
- Alvin Holder (Old Dominion University) and Harlan Jones (University of North Texas Health Sciences Center), “Developing an Impactful NIH and NSF Biosketch” and “Viewing your Grant from the Reviewer’s Perspective”
- Cynthia Nau Cornelissen (Virginia Commonwealth University), “Reflections on the Webinar Series”

Participants also learned about common pitfalls to avoid in proposal preparation and gained tips for crafting succinct specific aims. In addition, GWC Online included pre- and post-webinar assignments, structured mentoring, and an online community of practice. The assignments provided a foundation for enhancing the webinar training, and the mentoring ensured participants had numerous opportunities to ask questions during and after the webinars. The online community provided a place for participants and facilitators to share readings and resources.

On follow-up surveys, participants reported knowledge gains and benefits.
as a result of participating in the GWC Online webinar series. When asked to rate their knowledge before and after participation, participants scored their knowledge on the webinar topic after participation 60–100% higher than their before scores. Additional benefits noted by survey respondents included new insights on the grant review process, useful resources for budgeting, and learning the most important aspects of proposals.

The second portion of the program consists of a multiday in-person course. The ASM Grant Writing Course complements the webinar series and will focus on intensive writing, small-group interactions, and one-on-one feedback from experienced facilitators. Participants will submit in-progress proposals for pre-course assessment and leave with detailed plans for improving their grants, resources for developing future proposals, and a network of peers and mentors for critiques and advice. The in-person course takes place 12–14 August 2016 at the ASM Headquarters. The course is open to both ASM members and nonmembers. For GWC Online, nearly 70% of nonmembers joined ASM as a result of participation. Participation in both parts of the program is beneficial for attendees, but not required. In addition, the in-person course offers a registration discount to participants of the online program.

Planning is under way for the 2017 course activities. To learn more, visit http://www.asmgap.org.

**ASM Prepares Educators for Back to School Season**

We know fall classes are around the corner! ASM has the resources to help new and experienced faculty members design and plan a curriculum, continue developing professionally, and gauge student learning. First, allow the *Journal of Microbiology & Biology Education (JMBE)* to help you with your planning. Use ASM’s free, open-access content for peer-reviewed, assessed activities, and tools that can increase student engagement, improve retention, and convey difficult science concepts. For more information, visit http://www.asmscience.org/jmbe.

If you are interested in becoming an educator and want to develop introductory skills on course design, strategies, and career preparation, ASM has the training for you! The Science Teaching Fellows Online Course is a five-month, professional development opportunity that prepares doctoral-trained individuals for science teaching positions at community colleges, minority-serving institutions, regional or state colleges, and primarily undergraduate institutions. The course will take place from December 2016 until April 2017. The application deadline is 1 November 2016. For more information about this program, please visit http://www.facultyprograms.org/.

Looking to increase your students’ quantitative literacy? The Faculty Development Online Course is a four-part, live webinar series designed to provide faculty training on key subject areas. Participants receive guidance and support from subject matter experts and peers, while addressing the latest topics in science education. This year’s installment will focus on developing the quantitative skills of students. The course will run from September to December, 2016. For more information about the course, visit http://www.facultyprograms.org/.

Finally, each year the Society sponsors the ASM Conference for Undergraduate Educators (ASMCUE) where almost 400 science educators from all around the world gather to learn and share the latest information in the biological sciences and education research. If you were not able to join us this year, we are excited to share the dates and locations for the next two conferences:

- **ASMCUE 2017**: 27–30 July 2017 in Denver, Colorado
- **ASMCUE 2018**: 26–29 July 2018 in Austin, Texas

For more information, visit http://asmcue.org/.

**Branches: ASM Activities at the Local Level**

**Indiana Branch 2016 Annual Meeting and Plans for 2017 Meeting**

The Annual Meeting of the Indiana Branch of the American Society for Microbiology (IBASM) took place on April 1–2, 2016, on the campus of Indiana University-Purdue University, Fort Wayne (IPFW). There were over 60 in attendance, with 27 abstracts in microbiology and immunology presented by 15 undergraduate, four M.S. graduate, and eight Ph.D. graduate students.

The meeting began on Friday evening with a talk from ASM CEO Stefano Bertuzzi highlighting ASM programs and resources, followed by a presentation by ASM Past-President Timothy Donohue (University of Wisconsin-Madison), who spoke on how microbial sciences help to produce fuels and chemicals from plant biomass. Saturday morning opened with a student poster session and was followed by a public health talk from the Allen County Health Commissioner, Deborah McMahan. ASM Distinguished Lecturer Nancy Hanson (Creighton University) closed out the meeting with her presentation on the regulation of beta-lactamase production.

Student oral presentations were well-received and covered a variety of research topics. Chance Smith from Indiana University Southeast discussed the characterization of bacteriophages from water samples using *Caulobacter crescentus* as the host organism while M. F. Mohamed from Purdue University shared his research on “Targeting Intracellular Pathogenic Bacteria with a Kanamycin Antibiotic Peptide Conjugate.” Additional student presenters included Melissa Beaty from IPFW, who spoke about “Mycobacterial Acyltransferase Involved in Dormancy
Associated Lipid Biosynthesis,” and Sylvie Kristoff from Indiana University-Purdue University Indianapolis (IUPUI), who shared her findings on the effects of nicotine in the binding of Streptococcus mutans to collagen, fibrinogen, and laminin.

Awards were presented to the first- and second-place student poster presentations at the undergraduate, M.S. graduate, and Ph.D. graduate levels. At the undergraduate level, first place went to Janine Bennett of IPFW for her work on the regulation of sunscreen biosynthesis in cyanobacteria, while second place was awarded to Xyryl Pablo, also of IPFW, for her poster entitled, “Mycobacterial Protein mEtA and its Role in Resuscitation from Stationary Phase.” M.S. student award winners included first place to James Price of IPFW who looked at the microbiome of the green sea turtle, and second place to Jamison Law of IPFW for his work studying the biochemistry of a mycobacterial glycerol-3-phosphate acyltransferase. All of the award winners in the Ph.D. division were from Purdue University, with first place awarded to Shankar Thangamani who presented research on “Repurposing Auranofin, an FDA Approved Antirheumatic Drug for the Treatment of Staphylococcal Infections.” There was a tie for second place for two excellent poster presentations, one by Waleed Younis who discussed the use of carbonic anhydrase inhibitors against enterococcal infections, and the other by M. F. Mohamed, whose research was also delivered in the oral presentation noted above.

The IBASM meeting was organized by the executive committee and student officers Jamison Law of IPFW and Grace Gomez of IUPUI. Our sponsors include the ASM Branches program for support and funding, Pearson Publishing, as well as the College of Arts and Sciences and Department of Biology at IPFW.

To view short video vignettes from the meeting, check out the Web page containing highlights of ASM CEO Stefano Bertuzzi’s Branch Listening Tour at http://www.asm.org/index.php/listening-tour.

Mark Your Calendar for 2017 IBASM Meeting. Please join us for next year’s meeting at Turkey Run State Park in Marshall, Indiana on March 31-April 1, 2017! For more information on the Indiana Branch please visit http://ibasm.iweb.bsu.edu/; for more information on the ASM Branch program, see http://www.asm.org/branches.

Tanya Soule  
President-Elect, Indiana Branch ASM  
soulet@ipfw.edu
Microbe Mentor

How Important Is a Postdoc for a Teaching Career?

Amy Cheng Vollmer, Virginia Balke, Carie Frantz, and Thomas E. Hanson

How critical is a postdoc if I want to teach at a primarily undergraduate or 2-year institution?

To bring a broad perspective to the issue, Microbe Mentor editor Thomas Hanson asked three microbiologists at different career stages and types of institutions for their thoughts. Dr. Amy Cheng Vollmer is a Professor of Biology at Swarthmore College, Dr. Virginia Balke is an Instructor and Project Director at Delaware Technical Community College (DTCC), and Dr. Carie Frantz is an Assistant Professor of Geochemistry and Biogeoscience at Weber State University.

Amy Cheng Vollmer’s research focuses on the stress response in *Escherichia coli*, and is moving towards microbiome characterization. She is the sole microbiologist in a Biology Department, where she has served twice as Department Chair. Research experience for students is an important part of the curriculum at Swarthmore and Dr. Vollmer has hosted over 70 students in her lab to date. She has previously written about her job in the August 2000 *ASM News* (66:459–462).

She began by elaborating on what primarily undergraduate institutions (PUIs) are and are not relative to research-intensive large universities (Carnegie R1 institutions). “The metaphor I use is this: if an R1 is the winter Olympics, a PUI is the summer Olympics—you still have to be at the top of your game, it’s just a very different game.” PUIs are much more diverse in their missions, histories, their expectations of faculty members, and how effort is counted. “Some PUIs do not expect any research at all, just teaching—lots of it; other PUIs will have both teaching and research responsibilities; be wary of ones that expect research but do not support it with any funding or facilities. If you are interested in a job that has both teaching and research expectations at a top-tier PUI, then you absolutely MUST have postdoctoral experience.”

Preparation is key. “Knowing the history of the school is part of the homework you need to do to prepare for your application and your interview.” She argues that postdoctoral experience is key for at least two reasons. First, “. . . because you will likely be the only microbiologist on your campus. Oh, there might be others who use *E. coli* as a production source for plasmids, but it is unlikely that you will be able to go down the hall and have an in-depth conversation about reducing potential or archaea or peptidoglycan!” Second, “At a top-tier PUI, you will be expected to write research proposals to fund your projects from extramural sources: NSF RUIs or NIH R15 AREA grants. You must have a very productive postdoctoral record, meaning numerous publications, with first authorship on several of them. This is an indication that you have momentum coming out of the postdoc and projects that are ‘ready to go’ in your soon-to-be-independent laboratory.” Selecting a postdoc for those that are interested in a career at a PUI is important: choosing the right lab and supervisor is a key factor. “There are some PIs who are not supportive of any career trajectory other than R1 university faculty positions. Besides being unrealistic, it shows a general lack of consideration for diversity, which—in my opinion—is a red flag about that laboratory environment.” At the close, she emphasized the importance of experience. “Teaching experience can be gained in different ways: actually teaching, filling in for a professor when they are away, organizing a colloquium series or conference (long-term planning, logistics, etc.), or attending teaching workshops. There is a vast literature on pedagogy and active learning in an area called ‘the Scholarship of Teaching and Learning (SoTL)’ that is extremely useful for someone who is considering a PUI.”

Virginia Balke has spearheaded efforts to incorporate research experiences in courses at 2-year institutions like DTCC supported in part by several NSF awards. Balke has been teaching in the DTCC Biology & Chemistry Department for over 20 years and has most recently been mentoring students on independent projects ranging from soil microbial com-
She is a geomicrobiologist interested in microbiology of Geosciences at Weber State University. She also began by emphasizing the diversity of institutions and requirements. “At some institutions, a Ph.D. in the course-related discipline is a requirement for gaining employment, where at other institutions a degree in a related field is sufficient. For example, teaching microbiology at some institutions requires a Ph.D. in microbiology and at other institutions, a Bachelor’s or Master’s degree in microbiology, biology, or biochemistry will suffice as well as for teaching a range of other courses such as anatomy and physiology.” She is in favor of postdoctoral experience and notes that the climate for research at 2-year institutions is changing.

“Having extensive research experience is a benefit, given the current national movement to incorporate undergraduate research experiences into courses at community colleges . . . The diversity of projects and experiences from graduate school and a postdoc provides more to draw from for designing research-related curriculum over a variety of courses.” One suggestion is, if your postdoc situation allows it, seek out adjunct instructor appointments to gain experience and contacts in the environment and to prepare for teaching. “Review the latest education research to be familiar with high-impact classroom practices and to write a knowledgeable philosophy of teaching statement. Also seek out advice from community college instructors about the differences in teaching at an institution where you may be completely responsible for the class including laboratory preparation and do not have TAs to assist with grading or recitation sessions.” As with Amy Vollmer’s suggestion, do your homework. “If you are applying for a job at a 2-year institution, do some investigation as to whether the college faculty and administration are heavily vested in the use of undergraduate research as a student engagement and retention tool.” She closed with a reflection on her experiences. “Teaching at a 2-year institution is rarely the primary goal one considers as a graduate student or postdoc, though for most of us, we could not imagine a more fulfilling job where we have incredible impact on nontraditional students.”

Carie Frantz is a newly minted (very newly minted—as of June 2016) Assistant Professor of Geochemistry and Biogeoscience in the Department of Geosciences at Weber State University. She is a geomicrobiologist interested in microbe—Volume 11, Number 8, 2016 • 363 mineral interactions and is plotting a full-scale scientific assault on the enigmatic microbialites of the Great Salt Lake.

Freshly out of her postdoc, she feels it was entirely worthwhile. “As a line item on your CV, a postdoc isn’t usually a requirement for working at a PUI or 2-year institution, but it’s time well invested. Doing a postdoc is a great way to develop new skills and expertise, expand your network, beef up your CV, and get a paycheck during the postgrad job hunt. It also demonstrates a commitment to research, which many PUIs and 2-year schools want.” Doing a postdoc also gave her a solid perspective on what she wants to do and why. “When I finished my Ph.D., I wasn’t sure what I ultimately wanted to do other than that I knew that I wanted to stay in science. After a year adventuring in the Andes where I missed science and the academic environment, I spent two years as a postdoc at the University of Washington’s Applied Physics Lab working on a really cool sea ice microbiology project. As a soft-money research institute, it is about as different an environment from a PUI as you can get. My postdoc experience made me realize that while I love research, my favorite part of my job was teaching and mentoring students.”

Her postdoc experience also allowed her to become fully independent, echoing a sentiment from Vollmer. “That independence is critical, perhaps even more so at a primarily undergraduate or 2-year institution, because chances are you won’t have peers at your institute who do anything remotely similar to what you do. It can feel awfully lonely unless you’re used to working in a vacuum (which a postdoc can seem like) and have learned to aggressively pursue collaborations and confidently sell what you do, and why it’s exciting, to everyone you meet.” In addition to getting teaching experience, she noted that getting mentoring experience as a postdoc and learning how to talk about your mentees’ research is valuable. “One thing that is easy to do during your postdoc is to mentor undergraduates. Come up with a few subprojects related to what you’re doing that a student could take on . . . Being able to talk about your students and their accomplishments in applications and interviews demonstrates that you know how to lead student-driven research.” Applicants with postdoc experience for these positions are now common and for her “. . . it was definitely (and explicitly) considered a plus in my application.”

In the end, the choice to postdoc or not should
be driven by your career goals. Therefore, defining your career destination and knowing the requirements for that position, i.e. doing your homework, is critical to determining whether a postdoc will be necessary to get there or not. While a postdoc may not be required for every type of PUI or 2-year institution, our group, which represented the full spectrum of career stage and institution types, was unanimously positive about the benefits of doing one.

ASM’s New Career Website: Cultivate Your Career

Visit asm.org/careers for

- Professional development, volunteer, and funding opportunities
- ASM’s job board – Career Connections
- Profiles of microbiology career paths
- Articles on writing resumes, elevator pitches, networking, and more!
Application Deadlines

Undergraduate Faculty Research Initiative Fellowships. Early-career (and future) undergraduate STEM educators are encouraged to apply for a 2016 ASM-NSF LINK Undergraduate Faculty Research Initiative (UFRI) Fellowship. This nascent professional development resource trains STEM faculty to develop undergraduate research programs by initiating successful research partnerships. As part of the fellowship, LINK will provide travel subsidies of up to $2,000 to (i) increase participation of undergraduate STEM educators at eight eligible ASM-sponsored research conferences, (ii) encourage networking and collaborations with potential research partners, and (iii) access resources and mentoring to advance undergraduate research programs. Fellowship applications are accepted on a rolling basis for each of the eight conferences. The deadline is 19 August to be considered for a UFRI fellowship for the ASM Conference on Beneficial Microbes (Seattle, WA).

WWW: http://www.asmlink.org/ufri
Deadline: 19 August 2016.

Turning Your Science into a Company. To guide beginning investigators in combining their research interests with entrepreneurial ventures, ASM offers its third annual “Turning Your Science into a Company,” a workshop on establishing scientific businesses. Join the program on 6–8 October 2016 in Washington, D.C., to and receive valuable tips, advice, and resources from successful principals of leading start-up and small scientific companies. The workshop features examples from the biotechnology industry and specifically targets advanced graduate students, postdoctoral fellows, and early-career scientists.

Turning Your Science into a Company is sponsored by the ASM Committee on Graduate and Postdoctoral Education.
Deadline: 20 August 2016.
ASM Meetings Calendar

29 August–1 September 2016.
5th ASM Conference on Salmonella.
Potsdam, Germany.
http://conferences.asm.org/

9–12 September 2016.
6th ASM Conference on Beneficial Microbes.
Seattle, Wash.
http://conferences.asm.org/

ASM Conference on Infection and Cancer.
Washington, D.C.
http://conferences.asm.org/

11–14 December 2016.
ASM Conference on Antibacterial Development.
Washington, D.C.
http://conferences.asm.org/

6–8 February 2017.
ASM Biothreats Conference: Research, Response and Policy.
Washington, D.C.
http://conferences.asm.org/

33rd Clinical Virology Symposium.
Savannah, Ga.
http://conferences.asm.org/

1–5 June 2017.
ASM Microbe 2017.
New Orleans, La.

March 2017.
ASM Conference on Innovative Microbial Ecology for Mitigation of Antibiotic Resistance and Bacterial Diseases.
www.asm.org/conferences

March 2017.
ASM Conference on Mechanisms of Interbacterial Cooperation and Competition.
www.asm.org/conferences

April 2017.
ASM Conference on Tuberculosis: Past, Present and Future.
www.asm.org/conferences

May 2017.
ASM Conference on Interplay of Viral and Bacterial Pathogens (ASM-ASV collaboration).
www.asm.org/conferences

September 2017.
2nd ASM Conference on Rapid Applied Microbial Next-Generation Sequencing and Bioinformatic Pipelines.
www.asm.org/conferences

About the Calendar

The ASM Meetings Calendar is provided as a service to readers of Microbe. It includes annual meetings and conferences organized by the Society. Detailed information for these events is published in the ASM Meetings and Conferences insert, which appears bimonthly in the center of Microbe.

As an added benefit of membership in ASM, an online calendar of microbiology-related meetings hosted by ASM and by other organizations is available through the ASM website. Any organization may submit items for the online calendar provided that submissions are of obvious interest to microbiologists. ASM will not permit announcements to appear in the calendar when the subject matter and dates conflict with ASM meetings or workshops. The calendar is located at https://info.asm.org/index.php/meeting-and-event-calendar. All entries in the online calendar are limited to conference name, dates, location, website, and contact information (person, address, telephone, fax, and/or e-mail). When websites and e-mail addresses are provided, links to them will be established. Because of the volume of submissions received, ASM staff is unable to provide proofs or other confirmation of receipt of each listing. Submit items for the online calendar through the “Add a new event/deadline” link on the Meeting and Event Calendar page.
Employment

POSITIONS AVAILABLE

Postdoctoral Positions in Enzymology and Microbiology

Postdoctoral positions are available for enzymologists and microbiologists in enzyme and pathway discovery as part of a new multidisciplinary Program Project (P01GM118303, Novel Strategies for the Discovery of Microbial Metabolic Pathways). We are especially interested in applicants with demonstrated expertise in microbial genetics or mechanistic enzymology. The Program Project has the goal of developing sequence/structure-based strategies for facilitating assignment of in vitro enzymatic and in vivo metabolic roles of widely conserved enzymes of unknown function discovered in genome projects, a crucial limitation in microbial genomic biology. The project integrates bioinformaticstics, genetics, and metabolomics, structural biology, and computation with enzymology. The components of the Program Project are located at the University of Illinois (enzymology and microbiology; J. E. Cronan and J. A. Gerlt), Albert Einstein College of Medicine (structural biology; S. C. Almo), and University of California, San Francisco (modeling, docking, pathway prediction; M. P. Jacobson, A. Sali, and B. K. Shoichet). Due to the collaborative and multidisciplinary environment, the Program Project provides an opportunity to receive training in several areas. To apply or request details, please send an e-mail to enzymes@igb.illinois.edu.

Postdoctoral Position—Microbiology and Sediment Bioremediation

A postdoctoral position is immediately available at the University of Minnesota to work on the bioremediation of contaminated estuarine sediment by the deposit-feeding polychaete Capitella teleta and its microbiome. The postdoctoral project will examine the relationship between this worm and its microbiome and quantify the importance of the microbiome for contaminant metabolism and sediment bioremediation. All applicants must have expertise in microbiology, microbial ecology, and biodegradation. The position is for 2

Employment Advertising

Microbe is published monthly and available to nearly 40,000 ASM members and institutional subscribers. Lead time for employment ads is about 3 weeks. Microbe is mailed around the 8th of the month of issue, but the delivery date is not guaranteed. Please consider delivery dates when setting application deadlines.

ASM does not accept classified advertisements that indicate a limitation, specification, or discrimination on the basis of race, religion, national origin, sex, mental or physical disability, age, or any other matters which may not be lawfully considered in making employment decisions. Employment notices that discriminate against microbiologists on the basis of a particular board certification or doctoral degree will not be accepted. Such advertisements will be rejected unless it can be established that the position by state or federal law or regulation requires a specific board certification or doctoral degree.

Classified

Classified ads must be typed, double spaced, with normal sentence capitalization (capital and lowercase letters). Microbe cannot accommodate requests for extra capitalization, boldface type, or other text or layout enhancements in classified ads.

Include the name and telephone and fax numbers of a contact person for questions about your ad copy. Incorrectly typed ads or ads with application deadlines earlier than the 15th of the publication month requested cannot be guaranteed placement in that issue.

Deadlines: Your ad must be received by the 1st of the month before the publication month to ensure timely publication (e.g., to appear in the September 2016 issue, your ad must be received by 1 August 2016).

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<th>Words</th>
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<td>1–50</td>
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<td>151–200</td>
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Small Things Considered

Kiss and Make Up: Myxococcus xanthus demonstrates bacterial cooperation

http://schaechter.asmblog.org/schaechter/2015/10/kiss-and-make-up-myxococcus-xanthus-demonstrates-bacterial-cooperation.html

by Ada Hagan

If there’s a hot topic in microbiology, it’s bacterial interaction and communication. Bacteria “talk” to each other using a complex chemical language we are only just beginning to understand. Quorum sensing allows communication between spatially separated cells of similar species. Functioning similarly, bacteriocins warn nonimmune bacteria away from a bacterium’s established niche. Type VI secretion systems also help a bacterium protect its niche, but by initiating contact between cells. Here, I’ll describe another instance of cell-to-cell interaction where bacteria don’t just communicate, but also heal.

First, a bit about the species involved. Myxococcus xanthus is considered a “social” species of bacteria, requiring a large population to enhance survivability. *M. xanthus* aggregates move together using a form of twitching motility to find nutrients, or if nutrients are lacking, to create a complex, differentiated structure. In it, some bacteria make spores to ensure long-term survival against extreme conditions.

Bacterial cells must adapt in order to survive changes in temperatures, radiation exposure, or shortages in food supply. All of these stresses can slow a bacterium’s ability to replicate quickly or respond to damage in the DNA or outer membrane (OM). Once damage occurs, most bacteria are on their own to either repair and survive, or die. Researchers at the University of Wyoming have recently learned *M. xanthus* cells cooperate with each other to make repairs in the outer membrane.

This process, called Outer Membrane Exchange (OME), is a bidirectional transfer of the outer membrane lipopolysaccharide (LPS) between two bacterial cells. Two surface proteins, TraA and TraB, act somewhat like Velcro hooks to bring cells close enough for OME to occur, but are also responsible for OME specificity. Unlike Velcro, which has reciprocal hooks and latches, TraA proteins only recognize identical forms of TraA on the other bacteria. In other words, if one bacterium expresses TraA, and another TraA’, they won’t be able to perform OME. This prevents *M. xanthus* from accidentally helping distantly related, or rival, *M. xanthus* populations.

Once TraA and TraB have initiated the junction between two bacteria, they appear to merge OM’s, trading LPS along with proteins at the cell surface. This effectively dilutes the damage from a few bacteria to the rest of the bacterial population, thus enhancing survival of the group.

In addition to repairing damage to the outer membrane, the exchange of LPS by OME helps restore mobility and the ability to sporulate. To demonstrate this, the authors created *M. xanthus* mutants lacking *wzm*. The *wzm* genes are responsible for synthesis of O-antigen, which is required for the formation of fruiting bodies prior to sporulation and social motility. *M. xanthus* lacking *wzm* are less motile and produce fewer spores than the *wzn*-containing wild-type parent strain. If the mutant is grown with *M. xanthus* expressing TraAB, however, both motility and sporulation improve. This is not the case when *M. xanthus Δwzm* is cocultured with *M. xanthus ΔtraA*, since OME cannot occur.

In another set of experiments, the authors looked at the effect of OME on *lpxC* mutants. LpxC is required for lipid A synthesis, which is essential for cell survival. Using a vanillate inducible promoter, the cells expressed LpxC and survived. By withholding vanillate, however, researchers were able to deplete LpxC from cells. OME from healthy donor cells expressing TraA was able to rescue LpxC-depleted cells, enabling survival past 12 hours.

The benefits of OME don’t stop there. OME helps improve cell permeability, and reduces sensitivity to antibiotics. It also acts as an information relay, improving response to environmental stressors. The authors suggest that in this scenario “scout cells” report on exterior environmental conditions via OME, sharing alterations in protein expression or lipid modifications. This process would enable the bacterial population to adapt rapidly to their environment.

Known to be “social” bacteria, *Myxococcus* demonstrates behaviors such as swarming and complex biofilm formation. OME, however, requires more cooperation than previously observed, since otherwise healthy bacteria accept damaged LPS. With benefits ranging from first aid to scouting out changing environments, OME is truly a multifaceted survival strategy. Does this give a new meaning to “kiss and make up?”

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