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ASBMB TODAY

THE MEMBER MAGAZINE OF THE AMERICAN SOCIETY FOR BIOCHEMISTRY AND MOLECULAR BIOLOGY

THE CAREERS ISSUE

American Society for Biochemistry and Molecular Biology

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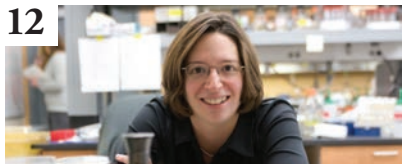

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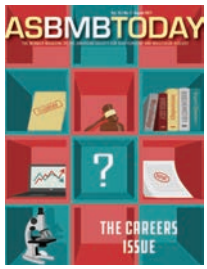
The Careers Issue: Here are 20 pages of wisdom, tips and encouragement to get you where you want to be.



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ASBMBTODAY
THE MEMBER MAGAZINE OF THE AMERICAN SOCIETY FOR BIOCHEMISTRY AND MOLECULAR BIOLOGY

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Career challenged? We have a lifeline

By Comfort Dorn

My first career goal was to be the Virgin Mary. I draped a big blue scarf over my head and wandered around singing "Silent Night." My mother was appalled; we weren't even Catholic. But at the age of three, I had few female role models.

As my horizons broadened, those haloed dreams faded, replaced by aspirations to become a nurse (Cherry Ames), a ballerina (the Sugar Plum Fairy), a Pilgrim (don't ask). These goals shared a common thread: Beyond the wardrobe, I had almost no idea what was involved in the job.

Even in high school and college, where career planning is ostensibly a focus, it was hard to get a handle on just what someone employed in the fields I briefly considered actually would do. Really, how does a trained anthropologist spend her days?

I share this foolishness as a prelude to the special careers section in this issue of ASBMB Today.

If you're reading this magazine, you probably have — or aspire to have — a job in science. Maybe you put on a tiny lab coat or built exploding volcanoes as a kid, or maybe you got hooked by a great teacher. Either way, you followed a rigorous educational path to realize your dream. But what exactly is that dream? And how does it morph into a reality with a paycheck?

Some people may perambulate seamlessly from classroom to lab, where their fantasies of hard work, discipline and reward are realized. But there are fewer benches than trained researchers to fill them. And maybe academic research wasn't such a great fit for you after all. Maybe your needs and abilities evolved. Maybe you got a great job and lost it, sending you back to square one.

Fifty years ago, you were expected to find a job right out of school and stay at one institution until you retired. If you've earned academic tenure, this might still be true (and you can skip right past the career advice to John Arnst's article about gene editing), but for many of us, those days are gone. In just about every field, you need to be more of a shark now, constantly swimming toward the next professional target. And with all the other highly educated sharks out there, you need both navigational skills and a keen sense of smell.

But also like a shark (whose antisocial reputation is undeserved), as an American Society for Biochemistry and Molecular Biology member, you needn't go it alone. In this issue, you'll find advice to help you succeed in a variety of work environments. Diedre Ribbens offers tips on productivity. A quartet of authors provides lessons on emotional resilience. Raphael Luna explains the value of mentoring. Kathy Goss outlines how to segue to a nonresearch position in academia.

And on the career-development page at asbmb.org are resources for everything from exploring your career path to dressing for an interview.

Pro tip: Leave your blue Virgin Mary scarf at home.

Comfort Dorn (cdorn@asbmb.org) is managing editor of ASBMB Today.

Washington is listening — and we've got a story to tell

By Benjamin Corb

Politics in 2017 has become a full-contact sport. Whether it's the debate surrounding the future of health care, an ever-evolving policy on immigration or a never-ending stream of analyses related to the 2016 election, there is no lack of story lines spurring partisan political activities and filling the voicemails and email inboxes of policymakers. As the summer churns on and we reach the August recess, when members of Congress leave Washington to spend time in their home districts, opportunities emerge to talk about the issues important to you and to make a difference for your colleagues.

Every year for the past four years, the Public Affairs Advisory Committee has encouraged American Society for Biochemistry and Molecular Biology members to reach out to their elected officials during the August recess and meet with policymakers to talk about the importance of federal support for biomedical research. While the public affairs staff in our Rockville, Md., office meets with lawmakers and their staffs regularly, building personal connections at the local level is a critical part of successful advocacy. We are continuing this annual advocacy opportunity — and we need your help.

This year, we are looking for ASBMB members who are interested in talking to lawmakers about the exciting, lifesaving research that's happening in their own backyards. We want our members to tell the story of the promise and potential biomedical research offers, to highlight the number of people employed in this field, and to show how scientists put taxpayers' dollars to work in the laboratory setting.

After seven months of blistering political news, contentious town halls and an ever-changing Washington narrative, policymakers are looking for the good stories, the local activities that are making a difference for Americans from coast to coast. They are eager for opportunities to talk about what's working rather than what's broken.

In the past year, we've seen the National Institutes of Health's budget grow even in the face of requests from the White House to cut it. We've seen a bipartisan commitment from Congress to support the nation's biomedical research enterprise, and we want to take the opportunity to keep growing and building support. Getting involved is as easy as ever.

The public affairs staff has developed training modules to help you with messaging and help you talk about your science and explain its importance to policymakers. We are ready to work with you to schedule meetings, provide you with briefing materials and connect you with other local scientists who have experience in these efforts to collaborate and share ideas on how to make your story heard. Simply sign up by visiting asbmb.org/advocacy/grassrootsnetwork.

This summer, with political angst at a pretty high level, let's remind our policymakers that there are stories at home worth bringing back to Washington — and let's make sure these stories are fresh in their heads as they come back and set funding levels for next year.

Benjamin Corb (bcorb@asbmb.org) is director of public affairs at the ASBMB. Follow him on Twitter at twitter.com/bwcorb.

Hood and Roizman win National Academy of Sciences awards


HOOD


ROIZMAN

The National Academy of Sciences recently honored Leroy E. Hood and Bernard Roizman for their outstanding achievements in science.

Leroy E. Hood, president and co-founder of the Institute for Systems Biology and senior vice president and chief science officer at Providence St. Joseph Health, was presented with the NAS award for Chemistry in Service to Society. Established by E. I. du Pont de Nemours & Company, this award recognizes an individual whose contributions to chemistry have a significant impact on society.

Throughout his career, Hood has developed a variety of chemical tools that have had significant scientific impact. Hood notably helped pioneer the Human Genome Project through the development of the automated DNA sequencer.

Roizman, the Joseph Regenstein Distinguished Service professor of virology at the University of Chicago, received the Selman A. Waksman award in microbiology. Supported by the Waksman Foundation for Microbiology, this award recognizes a major innovation in the field of microbiology.

Roizman is being honored for his contributions toward understanding the mechanisms by which herpes viruses replicate and cause disease.

Hood and Roizman received their awards, each of which comes with a $20,000 prize, in April.

In memoriam: Claude Klee


KLEE

Claude Klee, a biochemist formerly with the National Institutes of Health, passed away April 3 after a heart attack. She was 85 years old.

Born in France, Klee studied at the University of Marseille, graduating in 1959. She spent more than 40 years at the NIH, beginning at the National Institute of Mental Health in 1959. In 1961, she joined the National Institute of Arthritis and Metabolic Diseases, working alongside Herbert Tabor. She began her own lab in 1966 and later joined the laboratory of biochemistry at the National Cancer Institute in 1974, where she would stay until her retirement in 2002.

During her retirement, Klee remained active in the NIH community. A pioneering biochemist, she was highly regarded for her research in the field of calcium-binding proteins and calcium-dependent signaling. Among her many honors, Klee received the Women in Science and Engineering Lifetime Achievement Award and the Federation of American Societies for Experimental Biology Excellence in Science Award.

She is survived by her two children, Ann and Charles.

Protein Society award winners: Hudson, Feigon, Hayer–Hartl, Kuriyan and Pagliarini

The Protein Society has recognized several members among the 2017 Protein Society award winners for their contributions toward advancing understanding of the structure, function, design and application of proteins.

Billy Hudson, the Elliott V. Newman professor of medicine and director of the Center of Matrix Biology at Vanderbilt University, has received the Carl Branden Award, bestowed on a protein scientist who has made a significant impact in the areas of education and/or service.


HUDSON

Among his many accomplishments, Hudson helped develop the Aspirnaut K–20 STEM Pipeline for Diversity Program, an initiative that aids and encourages underrepresented students to pursue education and careers in science, technology, engineering and mathematics.


FEIGON


HAYER-HARTL

Juli Feigon, professor of biochemistry at the University of California, Los Angeles, and Manajit Hayer–Hartl, research group leader at the Max Planck Institute, were selected as recipients of the 2017 Dorothy Crowfoot Hodgkin Award. This honor is given to a scientist whose research in protein science has greatly influenced the understanding of biology.

Feigon is being honored for her structural analysis of the Tetrahymena telomerase complex. Her research has provided novel insight into telomerase function associated with aging and cancer.

Hayer–Hartl is being honored for her research into the mechanism of GroEL and its cofactor GroES. Her research demonstrated that chaperonin profoundly influences the free-energy landscapes for some proteins.

John Kuriyan, professor of chemistry at the University of California, Berkeley, has received the Stein & Moore Award, which recognizes scientists who have made sustained high-impact research contributions toward protein science.

Kuriyan contributed to the understanding of the regulation of eukaryotic cell signaling and the phenom-


KURIYAN

enon of processivity in DNA repair. He also conducted significant research on the structural basis of regulating protein interactions and molecular mechanisms associated with cancer.


PAGLIARINI

David Pagliarini, lead investigator of metabolism at the Morgridge Institute for Research, has received the Protein Science Young Investigator Award, which recognizes an early-career scientist who has conducted impactful research in the understanding of proteins.

Pagliarini's research has greatly increased knowledge of mitochondrial protein function.

The awards were given out at the 31st Annual Symposium of the Protein Society in July.

Hamlish selected as U.S. representative to Youth Ag-Summit


HAMLISH

Noah Hamlish has been selected as one of five United States representatives at the 2017 Youth Ag-Summit.

The Youth Ag-Summit is a forum for young leaders to discuss and identify innovative solutions to challenges presented by global food security.

Hamlish is a Thomas J. Watson Fellow researching aquaculture practices in Thailand, Indonesia, New Zealand, Chile, Norway and Scotland. He received a Bachelor of Arts in biochemistry and molecular biology from Wesleyan University.

The 2017 Youth Ag-Summit will take place in Brussels, Belgium, where Hamlish will join an international delegation of 100 individuals from 49 countries to address global food security issues.

Sundquist receives Rosenblatt Prize


SUNDQUIST

Wesley Sundquist, distinguished professor of biochemistry at the University of Utah, received the Rosenblatt Prize for Excellence.

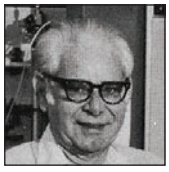
This prize, the most prestigious faculty award at the University of Utah, recognizes an exceptional faculty member who has made outstanding contributions to the university in teaching, research and/or administrative efforts.

Sundquist has resided at the University of Utah for 25 years. Since 2009, Sundquist has served as co-chair of the department of biochemistry, which he has helped grow and develop.

Sundquist is highly respected for his research into HIV replication and fundamental processes in cell biology and has made numerous publications throughout his career.

The award was established in 1983 in honor of Nathan and Tillie Rosenblatt and carries a $40,000 prize.

In memoriam: George Taborsky,


TABORSKY

Biochemist George Taborsky passed away peacefully June 3, 2016, after a long illness. He was 88.

Taborsky was born in Budapest, Hungary, on Feb. 12, 1928. He left Hungary at the end of World War II and resided as a refugee in Salzburg, Austria, before coming to the United States in 1949 on a full scholarship from Brown University.

Taborsky graduated from Brown with a Bachelor of Science in chemistry in 1951 and obtained his doctorate from Yale in 1956. He subsequently completed a postdoctoral research fellowship from the Carlsberg Foundation in Copenhagen, Denmark.

Taborsky returned to Yale as an instructor, joining the department of biochemistry before ultimately joining the faculty at the University of California, Santa Barbara, in 1970, where he would stay for the rest of his career.

He is survived by his wife of 63 years, Eva; his sister Theresa; and two children, Andrea and Peter.

Bowman receives Paul Talalay Award


BOWMAN

Caitlyn Bowman, a junior researcher in the Johns Hopkins School of Medicine, is being honored with the Paul Talalay Award.

Bowman conducts her research in the laboratory of her mentor, Michael Wolfgang, associate professor of biological chemistry at Johns Hopkins. Her research focuses on genetics and biochemistry, seeking to understand how cells and organisms get energy from food.

The award is named in honor of Paul Talalay, the John Jacob Abel Distinguished Service professor of pharmacology and molecular sciences at Johns Hopkins.

Bowman is one of 15 researchers being honored at Hopkins' annual Young Investigators Day ceremony, which recognizes both outstanding young researchers and their mentors.


Erik Chaulk (echaulk@asbmb.org) is a peer-review coordinator and digital publications web specialist at the ASBMB.

Progress in identifying lipid domains (rafts) in living cells

By Erwin London

Under which conditions lipid chemical heterogeneity results in the formation of coexisting lipid domains with distinct lipid compositions and properties in living cells has been a subject of intense research for decades.

In model membranes formed from lipid mixtures, spontaneous formation of tightly packed sphingolipid- and cholesterol-rich lipid domains (in the liquid-ordered state) that segregate from loosely packed domains richer in unsaturated phospholipids (in the liquid-disordered state) are detected and characterized easily.

However, analogous domains in cells are very small under most conditions — at or beyond the limit of detection for most techniques. This has led to much controversy as well as much work aiming to develop new methods to identify and characterize tiny nanodomains.

Very recent progress in living cells has been encouraging on several fronts. Studies using novel fluorescently labeled lipids with affinities for liquid-ordered domains similar to those of unlabeled lipids have revealed that specific association of raft-loving lipids with raft-localizing proteins occurs in living cells (1, 2). Single-particle-tracking measurements show that these interactions are lost in living cells when even minor changes in lipid or protein structure are made if these changes abolish raft-associating physical properties.

In other studies, super-resolution microscopy in B cells has found co-localization of raft markers with, and exclusion of nonraft markers from, the vicinity of clustered B-cell receptors on a size scale similar to that of the clusters (50 nanometers to 100 nanometers). This is indicative of the formation of ordered domains around the B-cell receptors. An analogous formation of nanodomains was detected around clustered cholera toxin, a molecule long known to induce the formation of ordered domains in vitro and in cells (3).

These studies extend previous work from other labs that reported lipid-domain-based molecular interactions in these systems. This is indicative of a robust underlying phenomenon.

Advances leading to an increased ability to visualize domains and manipulate their structure promise further progress. An even higher-resolution, super-resolution microscopy approach has been developed, which may allow visualization of domains that otherwise would elude direct visualization (4).

Finally, our own lab has devised a method efficiently to replace virtually the entire complement of plasma membrane outer leaflet lipids in living cells with exogenous lipids. This may allow fine-tuned control of domain formation and properties (5).

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Erwin London (erwin.london@stonybrook.edu) is a distinguished professor in the department of biochemistry and cell biology and in the department of chemistry at Stony Brook University.

How radiotherapies vanquish cancer cells

By John Arnst

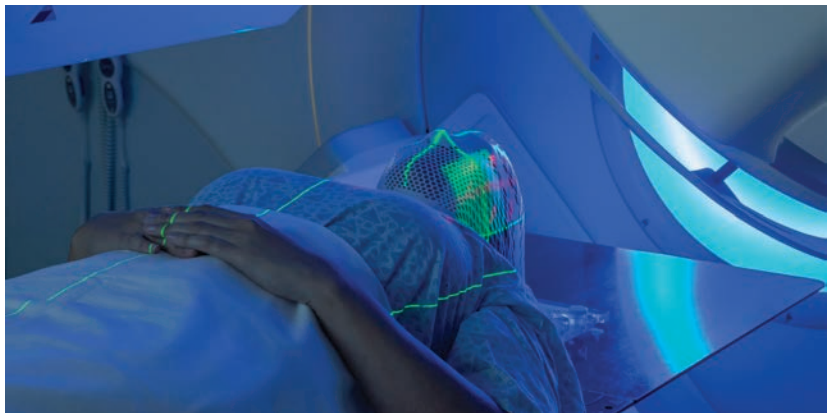
Tumor-shredding therapies aren't created equal.

When someone with cancer decides to treat the cellular aberration with radiation therapy, as more than 50 percent of cancer patients now do, their primary options are X-rays or particle beams. Despite being available at only a handful of treatment centers worldwide, particle beams, which use protons or carbon ions, possess a number of benefits over traditional X-rays.

The effects of the beams on the mechanisms that govern signaling within cells remain largely unexplored. A recent paper in the journal **Molecular & Cellular Proteomics** sheds some light on this matter.

To better understand the regulatory effects that the particle-based techniques have on the structure and signaling pathways of cancerous cells, researchers at the German Cancer Research Center, Heidelberg University and Heidelberg Ion Beam Therapy Center applied a combination of high-resolution mass spectrometry and SILAC to irradiated human lung adenocarcinoma cells. SILAC is short for stable isotope labeling by amino acids in cell culture; by incorporating amino acids labeled with heavy isotopes into cell cultures and comparing those cells' mass spectrometry peaks to those of identical, untreated cell cultures, researchers can examine the effects of an outside agent, such as radiation, on the protein makeup of a culture.

"The research interest is just finding out what radiation is doing to cells, to humans and to tissues," says senior author Martina Schnölzer at the center's Functional Proteome Analysis unit. "As a chemist, it was really interesting to work together with the radiation oncologists, because my background is more proteomics and not medicine."



Whereas X-rays destroy cancer cells by inflicting strand breaks on DNA's double-helix structure, which can be fixed by DNA repair mechanisms, protons and carbon ions tear the genetic structure apart with complex double-strand breaks, which cannot be repaired. This gives proton and carbon ion beams a larger relative biological effectiveness than X-rays, meaning they kill more cancer cells than X-rays do at the same dose. Additionally, particle beams deposit their energy in a more focused manner than X-rays, damaging to a lesser extent the healthy tissues surrounding tumors.

The researchers separated cultures of the human lung cancer cell line into two groups that were fed amino acids with heavy isotopes or light isotopes and irradiated subgroups of the heavy-labeled cells with x-rays, carbon ions or protons. They then performed a phosphopeptide enrichment to increase the concentration of phosphorylated proteins in each sample before subjecting the cells to mass spectrometry to identify changes that had occurred at the protein structure level and which sites had phosphate molecules added or removed. The addition or removal of these molecules is a key indicator that cells are attempting to mitigate damage and is known in aggregate as the phosphoproteome.

While the researchers observed only limited effects on lung cells at the protein level, they noticed altered phosphorylation regulation on 181 different protein sites, or residues, 151 of which had not been previously been known to be affected by irradiation.

"We've looked at differential quantification of the proteins and found that there is little happening as an initial event as a consequence of radiation, whereas the phosphoproteome is massively (dysregulated)," says senior co-author Amir Abdollahi at the center's Division for Molecular and Translational Radiation Oncology. This information will be helpful for designing future studies that examine the effects of radiotherapy, ionizing radiation and space radiation on cellular signaling processes, he says.

Future work for Schnölzer and Abdollahi will involve looking at the effects of radiation on a longer timescale to understand late effects of irradiation and examining its effects on pathways other than phosphorylation signaling.

John Arnst (jarnst@asbmb.org) is ASBMB Today's science writer. Follow him on Twitter at twitter.com/arnstjohn.

Miniseries explores interactions between microbes and the gut

By Dawn Hayward

The human gut is teeming with microbes that are beneficial and sometimes pathogenic. Our bodies have a symbiotic relationship with the "good guys" — some microbes break down the foods we eat, and others metabolize the drugs we take. But we are just beginning to uncover the interactions between metabolites released by microbes and the host's response. How does the host deal with a small compound released by a bacterium? What methods are currently available to catalogue and study these interactions? And how can this interplay be used to combat gastrointestinal diseases and others affected by these metabolites? The recent miniseries "Host-microbiome metabolic interplay" in the **Journal of Biological Chemistry** seeks to address these questions, exploring the advanced genomics methods used today and examples of such interactions to illustrate their connection to human disease.

In compiling the work for this series, editor Ruma Banerjee of the University of Michigan notes, she chose scientists who explored the "sub-areas" of microbial metabolomics in their research. The finished result gives the reader six articles that cover several connected aspects of this field. The first two highlight three "-omics" methods used and several natural products uncovered with these tools, while the last four get into specific examples of microbial metabolites and the host's response.

Emily Balskus and colleagues at Harvard University examine the workflow of advanced genomics techniques used to find natural products. Metagenomics, ecology-based approaches and in vitro biochemistry techniques were utilized in these case studies. The natural product and antibiotic lugdunin was discovered using an ecology-based approach in which a particular bacterial strain initially was found to inhibit the well-known pathogen Staphylococcus aureus. The cluster of genes correlating with this observation was identified and the specific metabolite isolated.

In the second article, the Eugene Chang laboratory of the University of Chicago delves into "-omics" methods. They explain how metagenomics, metatranscriptomics and metabolomics alone or in combination ultimately can aid in discovering therapies. Metagenomics, a mainstay of microbiome-host studies, uses shotgun sequencing to find novel

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Snapshot of JBC's 'Recommended Reads'

Every two weeks, the **Journal of Biological Chemistry** distributes a short roundup of papers and reviews that its editors think are worth your time. Here's a glimpse of recent selections. Sign up to receive the JBC's Recommended Reads at www.jbc.org/mission.

Yersinia effector protein-mediated phosphorylation of host gelsolin causes calcium-independent activation leading to disruption of actin dynamics

Pavithra Singaravelu, Wei Lin Lee, Sheena Wee, Umesh Ghoshdastider, Ke Ding, Jayantha Gunaratne, Jonathan M. Grimes, Kunchithapadam Swaminathan and Robert C. Robinson

Pathogens of the genus Yersinia, including those that cause plague, inject virulence factors called Yops into host cells that disrupt regulation of the actin cytoskeleton. Swaminathan, Robinson and colleagues report that the kinase YopO phosphorylates and thereby constitutively activates the actin-severing host protein gelsolin. The resulting actin disassembly in host cells could be responsible for the parasite's ability to thwart phagocytosis.

www.jbc.org/content/292/19/8092.

Mechanical forces regulate the reactivity of a thioester bond in a bacterial adhesin

Daniel J. Echelman, Alex Q. Lee and Julio M. Fernández

Adhesins are bacterial proteins that mediate adherence to surfaces, the first step in infection. Some adhesins from Gram-positive bacteria covalently attach to host-cell–surface ligands through a thioester bond. Fernandez and colleagues use single-molecule force spectroscopy to mechanically stretch adhesin domains and show that these force-dependent conformational changes influenced the reactivity of the bond, providing a possible mechanism for selectivity of adhesion.

www.jbc.org/content/292/21/8988

The extent of the temperature-induced membrane remodeling in two closely related Bordetella species reflects their adaptation to diverse environmental niches

Gabriela Seydlova, Jana Beranova, Ilona Bibova, Ana Dienstbier, Jakub Drzmisek, Jiri Masin, Radovan Fiser, Ivo Konopasek and Branislav Vecerek

The bacterial pathogen Bordetella pertussis is strictly adapted to human hosts, whereas B. bronchiseptica is also found in the environment. Vecerek and colleagues report that B. bronchiseptica adjusts its membrane fluidity, fatty-acid composition and production of virulence factors in response to temperature, whereas B. pertussis continued producing virulence factors at low temperatures without remodeling its membrane. These observations could be examples of trade-offs between optimal virulence and adaptive plasticity.

www.jbc.org/content/292/19/8048.

Modifiers of prion protein biogenesis and recycling identified by a highly parallel endocytosis kinetics assay

Boris A. Ballmer, Rita Moos, Prisca Liberali, Lucas Pelkmans, Simone Hornemann, and Adriano Aguzzi

The prion protein PrPC is a cell-surface protein that, when misfolded into its isoform PrPSc, causes prion diseases. Aguzzi and colleagues developed a high-throughput FRET-based assay to visually monitor PrPC internalization in real time. Using this method in combination with RNA knockdowns, the authors identified proteins involved in prion-protein trafficking. The authors propose that by allowing detailed analysis of prion biogenesis and trafficking, this method could be used to screen potential drugs for treating prion diseases.

www.jbc.org/content/292/20/8356.

The rare sugar N-acetylated viosamine is a major component of Mimivirus fibers

Francesco Piacente, Cristina De Castro, Sandra Jeudy, Matteo Gaglianone, Maria Elena Laugieri, Anna Notaro, Annalisa Salis, Gianluca Damonte, Chantal Abergel and Michela G. Tonetti

The capsid of the giant virus Mimivirus is surrounded by long fibers containing viosamine, a rare monosaccharide found in only a few bacteria. Tonetti and colleagues describe viosamine N-acetylation by a virus-encoded glycosyltransferase, hinting at possible relationships between these

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material. Metatranscriptomics gives gene expression data, and metabolomics looks at host metabolic pathway changes. Inflammatory bowel disease is discussed as an example; in particular, metagenomic analysis revealed lowered microbial diversity in patients, which may contribute to the disease. In addition, metabolomics studies revealed differing levels of key microbial metabolites in IBD patients compared to controls.

The remaining articles describe specific examples of how metabolites from microbes interact with the host and the pros and cons of such close relationships. J. Mark Brown and Stanley Hazen of the Cleveland Clinic highlight the importance of targeting metabolites released from microbes instead of the microbes themselves. They chronicle the identification and inhibition of trimethylamine N-oxide (or TMAO, a biomarker for cardiovascular diseases) as a paradigm for this approach.

The fourth article addresses drug metabolism. Our bodies add sugars called glucuronides to drugs, which aids in the drugs' elimination. Microbes, however, remove these sugars to use as an energy source. This puts drugs back into circulation and renders them toxic. Samuel Pellock and Matthew Redinbo of the University of North Carolina examine the types of molecules that glucuronides are added to and how microbes disturb this process.

Andreas Bäumler and colleagues at the University of California introduce the concept of colonization resistance and its disruption. Administration of antibiotics initially prevents bacteria from colonizing; yet after stopping the antibiotics or through antibiotic-resistant microbes, the colonization resistance is disrupted. The fifth article discusses what part of the microbial environment leads to a bacterium's rapid flourishing. The authors introduce the nutrient niche hypothesis, which posits that a microbe can outgrow its competitors when the one nutrient it needs most is abundant. Enterobacteriaceae, present in hospitals nationwide, is one such example described here, and oxygen is that nutrient.

The last article describes an additional layer of control: epigenetics. Kimberly Krautkramer, Federico Rey and John Denu of the University of Wisconsin describe the modifications that occur on the histones that organize DNA in the nucleus and how microbial metabolites potentially could influence gene expression levels.

Banerjee says this field is an "interesting frontier for understanding metabolism as it is regulated by the microbiome." The study of microbial metabolomics is in its early stages, and these articles are "beginning to scratch beyond the surface." Banerjee hopes this will spark more in-depth studies using classic biochemistry coupled with advanced genomic methods to catalogue the interactions between microbial metabolites and host responses, as much of this interplay stems directly from the foods we eat and drugs and supplements we take.

Dawn Hayward (dhaywar5@jhmi.edu) is a graduate student at the Johns Hopkins University School of Medicine.

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biosynthetic pathways in viruses and bacteria.

www.jbc.org/content/292/18/7385.

Nanomolar nitric oxide concentrations quickly and reversibly modulate astrocytic energy metabolism

Alejandro San Martín, Robinson Arce-Molina, Alex Galaz, Gustavo Pérez-Guerra and L. Felipe Barros

Astrocytes are abundant brain cells proposed to play important roles in fueling neurons, and high concentrations of nitric oxide (NO) have been shown to influence astrocyte energy metabolism. Barros and colleagues now report that physiological concentrations of NO cause cultured astrocytes to reversibly upregulate the rate of glycolysis and accumulate lactate by blocking mitochondrial respiration, suggesting that NO signaling helps regulate energy fluxes in the brain.

www.jbc.org/content/292/22/9432

Distinct modulatory role of RNA in the aggregation of the tumor suppressor protein p53 core domain.

Petar Stefanov Kovachev, Debapriya Banerjee, Luciana Pereira Rangel, Jonny Eriksson, Murilo M. Pedrote, Mafalda Maria D. C. Martins-Dinis, Katarina Edwards, Yraima Cordeiro, Jerson L. Silva and Suparna Sanyal

The tumor suppressor protein p53 is a transcription factor associated with various cancers when inactivated by mutation, protein–protein interaction or aggregation. Sanyal and collegues find that p53 aggregation can be influenced by interaction with RNA. Depending on the ratio of RNA to p53, RNA either induced or suppressed large amorphous aggregates or amyloid oligomers. These findings suggest that RNA structures may be involved in p53 regulation.

www.jbc.org/content/292/22/9345

New metabolic screening developed for newborns

By Alexandra Nail

Newborn screening programs are used worldwide for detecting and treating hereditary diseases. Many of these diseases, if left untreated, will cause complications that later become life-threatening. In a recent paper in the **Journal of Lipid Research**, Frédéric Vaz and colleagues from the Academic Medical Center, Amsterdam, and the Erasmus Medical Center, Rotterdam, describe the development of a new screen for Cerebrotendinous xanthomatosis, known as CTX.

PHOTO COURTESY OF FRÉDÉRIC VAZ

Researchers in the Netherlands used dried blood spots from infants to screen for Cerebrotendinous xanthomatosis, known as CTX.

CTX is estimated to occur in about one out of every 40,000 to 200,000 people and is caused by a deficiency of 27-sterol hydroxylase, an enzyme encoded by the CYP27A1 gene. Lack of this enzyme causes a metabolic block in bile acid synthesis. This block results in deficiency of primary bile acids cholic acid and chenodeoxycholic acid and accumulation of bile alcohols and cholestanol. The buildup of bile alcohols — which consist primarily of a tetrol named cholestenol — as well as cholesterol is thought to contribute to pathology seen in CTX patients.

Symptoms of CTX can present during infancy or in childhood and include neonatal cholestasis due to the bile acid production block, bilateral cataract and developmental delay. CTX often is diagnosed in adulthood and is characterized by both neurological and non-neurological symptoms. Supplementation with chenodeoxycholic acid starting at an early age can prevent CTX symptoms. "It is hard to swallow that an effective treatment for this severe disease is already available, but no validated newborn screening method is yet available," senior author Hidde Huidekoper stated. "The disease causes irreversible neurological damage, and diagnostic delay greatly affects the outcome of patients with CTX."

The method developed by Vaz and his team primarily relies on quantification of sugar-conjugated tetrols and amino acid-conjugated chenodeoxycholic acids from dried blood spots using negative ion electrospray mass spectrometry. This technology selects the ions based on their mass and, after fragmentation, detects specific fragments characteristic of the metabolites of interest. Importantly, using the researchers' new workflow, the samples do not have to undergo expensive and time-consuming derivatization steps. Removing the need for these steps allows for expansion of newborn screening programs and fast turnaround times for newborn diagnosis.

Using their methodology, the researchers were able reliably to distinguish CTX newborn samples from other bile acid-synthesis disorders using metabolite ratios of the sugar-conjugated tetrol to amino acid-conjugated chenodeoxycholic acid. Furthermore, their work easily can be integrated into current newborn screening programs at hospitals.

The identification of a consistent metabolic biomarker for CTX paves the way for a larger pilot study. "We think that the method we have now developed has the potential of being used as a one-tier screening method for CTX and can be implemented into newborn screening laboratories worldwide after conducting a successful pilot study," Huidekoper stated. Although Vaz and his team screened a total of 150 term and 50 preterm newborns, a much larger study is planned to include at least 100,000 newborn dried blood spots to validate their new technique on a grander scale. "We hope to really speed up the development of a suitable newborn screening method for CTX," Huidekoper stated, "and have established a collaboration with Andrea DeBarber at Oregon Health and Sciences University, and other international partners who are actively pursuing the introduction of CTX into newborn screening programs." It seems a better prognosis is on the horizon for CTX patients.

Alexandra Nail (alexandra.nail@uky.edu) is a doctoral candidate at the University of Kentucky.

A scientist who seeks stories and speaks her mind

Tricia Serio's new project documents the effects of sexism in academia

By John Arnst

Tricia Serio is a keen student of the barriers that allow and prevent change in people and proteins.

One of the country's leading experts in the mechanisms underlying prion misfolding, Serio also has written a number of op-eds in news outlets about under-discussed issues that scientists face. Last year, she launched a project, Speak Your Story, that seeks to document subtle sexism at scientific institutions as a prelude to designing methods to change and prevent it.

Serio has published 14 articles, nine of which were op-eds, about topics such as imposter syndrome, sexism in science, work–life balance and the need to increase college graduation rates in the U.S. Her writing appeared in the Huffington Post, Nature, The Hill and the Arizona Daily Star during the 2015–2016 academic year when she was one of 20 Public Voices fellows in Tucson.

The Tucson Public Voices Fellowship, sponsored by the University of Arizona's College of Social and Behavioral Sciences, the OpEd Project and the Women's Foundation of Southern Arizona, has been convening and pairing fellows in Tucson with journalists as mentors since 2013.

"The Speak Your Story project really came out of my involvement in that (fellowship)," Serio said. While working on an op-ed for Nature that addressed sexism in science, she said, "I realized that many women — in fact, every woman that I asked about it — could relate stories of things that were said to her at some point in her career that she took as negative toward women or toward her particular progress in the field."

Serio cautions that not all that negativity may have been intended. "As I've progressed in my career, I've become more open to asking people to clarify what they mean when they say something," she said. "I realized that I was misinterpreting things that were said to me, and I think that that's pretty common…(W)hen something's said to you that's disconcerting in some way, I think people hesitate to question it, especially if you're early in your training. So I wanted to write this piece to start a conversation, essentially, about having conversations along these lines."

Stories in a scenario

Serio's Speak Your Story website is a place for academics to share stories about being on the receiving end of comments that they perceived as negative or about making statements that they later realized could have been misinterpreted. The submissions are

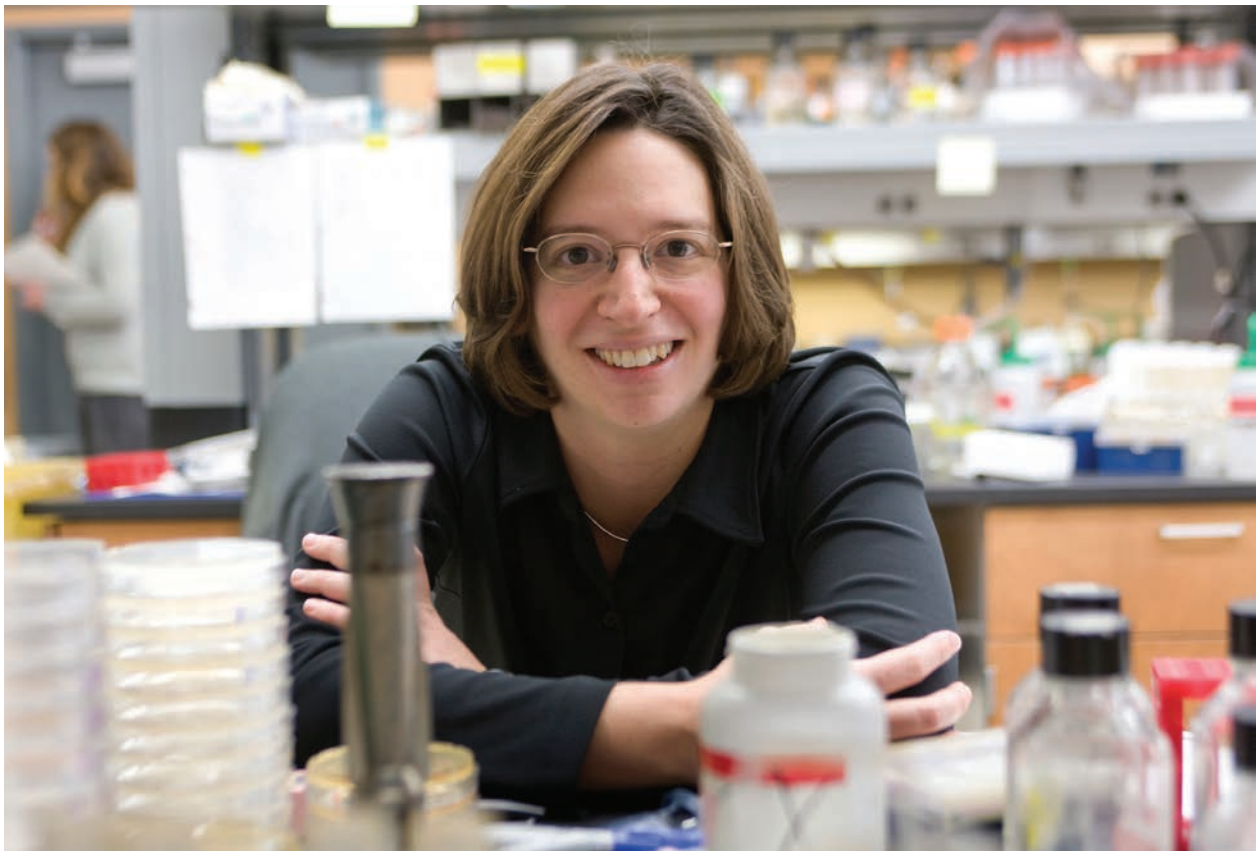


PHOTO COURTESY OF TRICIA SERIO

Serio in her former lab at Brown University.

made anonymously and disconnected from demographic information that's entered with the stories. "It's meant to be a place to share experiences," Serio said.

Serio and her collaborators have analyzed parameters including the STEM fields, gender and academic rank of the parties involved for 750 of the more than 1,000 stories it has received from scientists at all academic levels. Some of the stories that have poured in over the past year, from both the United States and abroad, have had unexpected results.

"I was really surprised at the number of stories people put in about comments about the way they dressed, and I wasn't anticipating that at all," Serio said. In response to those stories, she engaged one of the university's human resources staff members to help put together a workshop on implicit bias around dress, which she presented at her department's annual retreat last year.

In the morning workshop, two groups of faculty members were asked to consider hypothetical scenarios about a female graduate student. In one of the scenario, the student had completed her qualifying exams and arrived at her oral examination wearing a short skirt and T-shirt, owing to the exceptional heat and Tucson's casual ambience. In response, committee members made quiet comments that the student's attire signaled she was not taking the process seriously. The first workshop group was told to consider defending the student's dress choices and asking the committee members whether they would have commented on a male student's clothing choices, while the second group was told to consider informing the student that her attire was not professional.

"Because the scenarios focused on a graduate student experience, they

"There are some people in the world, where their nature seems to be to pay it forward … Tricia is somebody who has some really special qualities, thinking about people who come next and what's going to be possible for them." - Katie Orenstein, founder and CEO, OpEd Project

inspired a lot of dialogue among the faculty about the different professional challenges each faced throughout their respective careers," said Helena Rodrigues, assistant vice president of the University of Arizona's human resources department. When the graduate students arrived that afternoon, the faculty felt motivated to engage with them about these and other questions, said Rodrigues. "I don't know that that otherwise would have happened, and that was Tricia's sense as well. In that regard, it had sort of an unintended positive outcome."

Leading by connection

Serio showed similar initiative in the Public Voices fellowship. "She became a leader in the group and definitely a kind of glue that brought everybody together," said Teresa Puente, one of the senior facilitators with the OpEd Project.

Since the 2008 inception of the national OpEd Project, a leadership organization that seeks to accelerate the ideas and impact of underrepresented voices, the representation of women in public discourse has improved markedly. Before the OpEd Project's launch, about 15 percent of op-eds were written by women; after nine years, preliminary data show that rate has increased to more than 25 percent. In its first three years in Tucson, the program helped 58 fellows publish more than 170 op-eds.

Each cohort of the Public Voices fellowship, which just completed its fourth year, consists of 10 women who work at the University of Arizona and 10 women from elsewhere in the Tucson community. Martha Gilliland, a retired former chancellor of the University of Missouri–Kansas City and former vice provost of the University of Arizona, collaborated with Serio on an op-ed in The Hill about increasing the college graduation rate in the U.S.

"The joy in working with Tricia was experiencing how astute she is, how her mind moves immediately to 'What do the data show? Let's get the information," Gilliland said.

Gilliland was among the first people to see early drafts of Serio's op-ed about subtle sexism that appeared in Nature. "[The op-ed] just kind of epitomizes her, because she's willing to be vulnerable," Gilliland said. "It's very inspiring to other people, and it causes people to want to connect with her."

Serio's ability to connect with others ultimately became an asset to the survival of the program itself. Katie Orenstein, founder and CEO of the OpEd Project, recalled meeting Serio's cohort on the final day of the fellowship and informing them that the program in Tucson needed a new model if it was to survive beyond the next year.

"I was really surprised and moved by what happened," Orenstein said. "The entire room stepped up, and there were two people in the room, Tricia and Beth [Mitchneck], who kind of immediately took leadership."

Serio and Mitchneck, another of the fellows, launched a survey to track the impact of the fellowship, created a leadership committee and helped draft a letter, along with other cohort members, to the University of Arizona's provost. These actions ultimately helped ensure that the program could continue into the future.

"There are some people in the world, where their nature seems to be to pay it forward," Orenstein said. "I think some people are more future-minded, and Tricia is somebody who has some really special qualities, think-

An unexpected path

A first-generation college graduate, Tricia Serio grew up in Belleville, New Jersey, and attended Lehigh University in Pennsylvania. She originally planned to become a dentist before deciding to pursue molecular biology.

"Lehigh was about a little bit over an hour drive from where I grew up," she said. "If you ask my mom, she'll say it was very far."

Serio's family was, by her account, very traditional: Her father worked while her mother stayed at home. So, her academic trajectory as a molecular biologist was quite a departure.

"I don't think my mom ever, you know, projected this path for me. She thought I would follow in her footsteps and get married and have a family and stay at home," Serio said. Her decision to continue on to graduate school even further away from home, Serio said, came as a shock to her mother. "To be completely honest, I think that she thought it was more or less not appropriate for me as a woman to be doing that." On the other hand, her father "had the totally opposite perspective: He thought that I could do anything that I wanted to do. He was extremely supportive, very encouraging and willing to do whatever needed to be done to support me."

Serio enrolled in a doctoral program in molecular biophysics and biochemistry at Yale University, where she performed work on the Epstein Barr virus under George Miller. Her foray into prion folding began during her postdoctoral fellowship under the late Susan Lindquist at the University of Chicago, where she worked with prions in yeast models.

"We're really interested in how switches from one conformation to another occur in cells, what the forces are that block those switches from occurring, what the barriers are and how those barriers can be overcome to evoke these switches," Serio said.

During her postdoctoral fellowship, the University of Chicago lab that her husband, the microbiologist Jeffrey Laney, had been working in moved to Yale. Serio then moved back to New Haven to wrap up her postdoctoral work before taking a professorship at Brown University in 2002. In 2012, Serio and Laney moved with their children to Tucson, where she was most recently the head of the department of molecular and cellular biology at the University of Arizona.

Serio recently took a new position as dean of the College of Natural Sciences at the University of Massachusetts, Amherst.

ing about people who come next and what's going to be possible for them."

Serio is now working on op-eds that follow up on the responses received through Speak Your Story and analyzing the demographic data of the participants. She believes that publicly discussing issues women face as scientists was a natural extension of conversations she was already having about her career with members of her family.

"The vast majority of my family doesn't know what I do or why, or know anything about it, so I think I've been doing this for years and not realizing that I was doing it," she said. "I think my participation in the op-ed project made me realize that that has value outside of my own family.

"Talking to people who aren't getting the inside perspective always makes me understand things at a deeper level. I think that that's our role as scientists — to help facilitate that level of understanding."

John Arnst (jarnst@asbmb.org) is ASBMB Today's science writer. Follow him on Twitter at twitter.com/arnstjohn.

Upcoming ASBMB events and deadlines

AUG

8: Emerging Roles for the Nucleolus early registration deadline
9: Membrane-Anchored Serine Proteases registration deadline
30: Emerging Roles for the Nucleolus poster abstract deadline

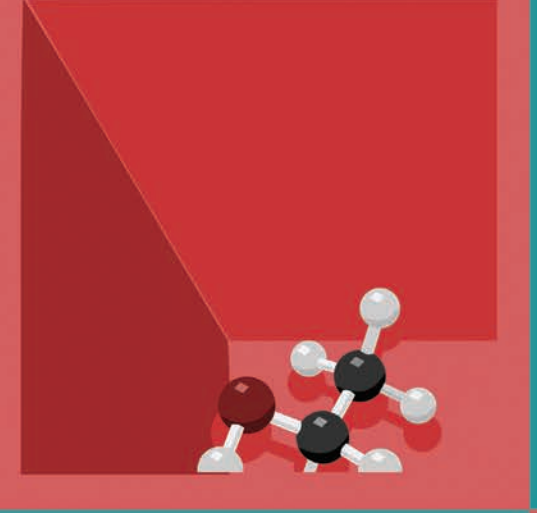
SEPT

12: Webinar: Compensation negotiation
14: Emerging Roles for the Nucleolus registration deadline
14–17: Membrane-Anchored Serine Proteases, Potomac, Md.
25: The Art of Science Communication online course registration deadline
29–30: Workshop: Preparing Science Professionals, Lexington, Ky

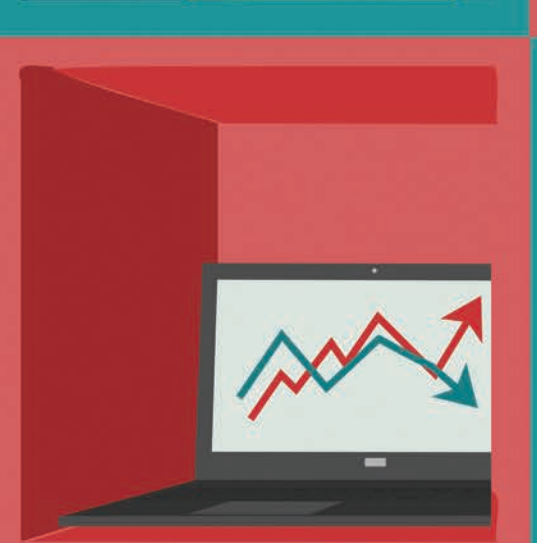
OCT

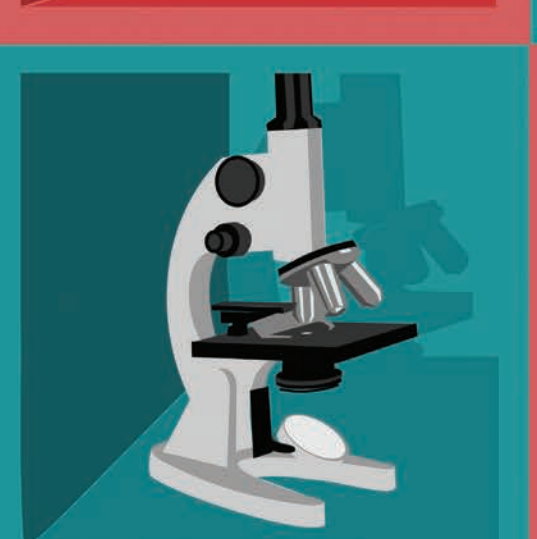
2: The Art of Science Communication online course begins
15: Fall accreditation deadline
19–21: ASBMB exhibits at the 2017 SACNAS National Diversity in STEM conference, Salt Lake City, Utah
21–22: Workshop: Catalyze Your Career, Tucson, Ariz.
26–29: Emerging Roles for the Nucleolus, Kansas City, Mo.

ASBMB
American Society for Biochemistry and Molecular Biology



THE CAREERS ISSUE





How can we help?

By Angela Hopp

The American Society for Biochemistry and Molecular Biology last year surveyed almost 2,000 of its members to find out what they most appreciate and need from the society. Respondents of every age indicated, not surprisingly, their top concerns relate to their careers.

The youngest cohort (30 and under) wanted career workshops and information about jobs outside academia. The 31- to 50-year-olds sought training opportunities to improve their teaching and learn about best practices in publishing. The 50-plus group prioritized networking and service to the community.

The survey also indicated that young members are far less likely to take advantage of the society's programs than the older groups. There are probably lots of reasons why the 30-and-unders participate at lower rates, but I don't want lack of awareness to be one of them. So, for the record, here's an inventory of ASBMB's career-development resources. Please take advantage of those that suit your needs.

Undergraduate research

www.asbmb.org/summerresearch

Undergrads should use our state-by-state database to identify summer research opportunities.

Career paths videos

www.asbmb.org/careers/careervideos

Not sure what you want to do with your life? Start figuring it out by watching these interviews of professionals with science backgrounds.

Webinars

www.asbmb.org/careers/webinars

We've had seven live webinars related to careers this year. If you missed them, watch the recordings and/or download the slides. Plus, there's one more slated for Sept. 12 about negotiating salaries.

Workshops

www.asbmb.org/workshops

Three in-person workshops are slated for the remainder of 2017: Preparing Science Professionals in September in Lexington, Ky., and Catalyze Your Career in October in Tucson, Ariz., and in November in Portland, Ore.

Grant-writing training

www.asbmb.org/grantwriting

This workshop yields impressive results; most participants end up with successful grants within two years. Information about the 2018 workshop will be available in the fall.

Communications training

www.asbmb.org/Outreach/Training/ASC

Can't travel for training? Take ASBMB's "The Art of Science Communication" online course to gain the skills, knowledge and mindset necessary to become a great presenter.

Video tutorials

www.asbmb.org/Careers/careerdevelopment/tutorials

Our video series has tips on networking, dressing professionally, building a personal brand and more. (See pages 24-25 and 30-31 for tips from those tutorials.)

Travel awards

www.asbmb.org/meetings

The society covers travel expenses for hundreds of undergraduates, undergraduate faculty, graduate students and postdoctoral fellows attending the ASBMB annual meeting. Deadlines to apply for next spring's meeting will be in early 2018. Don't miss this opportunity for free money!

Annual meeting

www.asbmb.org/meetings

Travel-award winners attend a two-day program on career exploration, skill acquisition, communication and networking. Established investigators have mixers, hands-on workshops and panel discussions on professional issues. Importantly, the Federation of American Societies for Experimental Biology's Maximizing Access to Research Careers Program has a whole slew of programming for job hunters. (See http://bit.ly/2mFrieL.)

Jobs board and blog

www.asbmb.org/careers

The ASBMB job board has new listings all the time. Every week, our jobs blogger posts positions she dug up for members. (Also, see some career advice from her on pages 26-29 of this issue.)

Angela Hopp (ahopp@asbmb.org) is executive editor of ASBMB Today and communications director at the ASBMB.

You need to work your way through school

Today's job market requires real-life skills along with academic training

By Andre Porter

Many of us enter college under the assumption that, for the next four or more years, our sole job is school. Years ago, this might have been the case. Today, however, if you've just graduated with your degree, you may find yourself back at square one. With employers requiring several years of experience in addition to education, some of you may wonder how you can compete.

It's undeniable that obtaining your education is a full-time job requiring more than 40 hours a week. However, focusing your efforts squarely on formal education will do you a disservice in the long run. According to the National Center for Education Statistics' report on the condition of education in 2017, the percentage of young adults who have obtained a bachelor's or higher degree increased from 29 percent to 36 percent between 2000 and 2016. At the same time, the percentage of Americans 65 and older staying in the workforce continues to increase. This means students are jumping into a workforce that increasingly is overpopulated with people who, at the very least, have the exact same basic knowledge as themselves. The key to ensuring competitiveness in the current job market is the complex act of balancing education with real-world work experience. If they do this effectively, new graduates may find themselves transitioning into their next stage with ease.

When I entered college at Howard University, I knew I wanted to contribute to science. However, how I would achieve this and what mechanisms I would use were up in the air. I started my college career in a science, technology, engineering and mathematics prefreshman program with the main goal of exposing undergraduate STEM majors to a world that was foreign to most of us, namely the research enterprise. Even before my first semester started, I began to see what my options were. We not only were shown the gamut of research being conducted around the U.S. but also were provided with mentorship and professional development for careers inside and outside academia.

"Instead of assuming that I should be qualified, I reprogrammed my thinking toward what I needed to do to gain the skills and experience required to be where I wanted to be. This led to spending my first summer as a college student working as a pharmacy technician."

Through this program, I visited labs with more resources than my home institution and attended scientific conferences I would not have had the opportunity to experience otherwise. Being around all this cutting-edge science had a profound impact on my outlook. It was easy to become blinded by the possibilities. What big discovery could I make? What lab would I work in? When would I run my own lab? And ultimately, how would I contribute to science? Not once did I think about what I needed to answer these questions.

Reality check

My aspirations were seemingly endless and, in retrospect, one-dimensional. I thought the only way I could have an impact on research was to become a bench scientist; in my mind, the playing field was wide open, and I just needed to jump in. Both of these notions, I would grow to learn, were far from reality.

Like many of my classmates, I reached out to investigators, inquiring about openings in their labs for the coming summer. I connected with a principal investigator and submitted my resume, assuming things would just fall into place. This, however, led to my first lesson in the workforce. While the investigator was interested in adding me to his lab, there were limited open positions and quite a number of interested applicants. It was clearly going to be a difficult decision. In the end, I was told that though my GPA was ideal, the slot was going to another student. Why? Because they had more experience.

It might be assumed that, by the

end of freshman year, all students are equal in respect to knowledge. This, however, isn't true. The reality is that many students enter college with some form of work experience, lab or otherwise, and that meant that I effectively began at a deficit.

If I did well in my studies, I thought, internships and jobs would welcome me with open arms. That was the narrative I was sold. Go to college, do well, and you'll be able to get a good-paying job. Not only was the idea of a simple college-to-job pipeline unrealistic, the part about it being "good" and "paying," I would soon find out, might not be real either.

Playing catch-up

If I ever was going to compete with my classmates, let alone the rest of the workforce, I realized that my job was not only to do well in school but also to obtain work experience at the same time. To this end, I began looking for any and all opportunities. Instead of assuming that I should be qualified, I reprogrammed my thinking toward what I needed to do to gain the skills and experience required to be where I wanted to be. This led to spending my first summer as a college student working as a pharmacy technician — a profession a world away from where I thought I should be.

As a pharmacy tech, I learned about policies that help protect patient privacy and the ins and outs of health insurance laws while also picking up medical terminology and gaining some knowledge of disease and drug interactions. Each day, I worked with a pharmacist to ensure that prescriptions were filled efficiently, and I had the opportunity to interact with all walks of life, which reinforced the importance of my job. Though this position lasted only three months, I was able to develop skills that I used to grow professionally.

With the knowledge I gained as a pharmacy tech, I was able to obtain an internship at Children's National Medical Center within the Pediatric Emergency Care Applied Research Network. This internship helped me get practical lab experience, gain knowledge in the management of multiple research projects and develop skills for working in an office. The internship, however, was unpaid. While the position didn't compensate me financially, it did compensate me experientially. My goal was to use this opportunity to translate into the next one, and working at CNMC did just that.

Sacrificing for the future

Working at CNMC helped me close the gap and in some cases outpace my classmates with respect to work experience. I knew that the time I put in, while unpaid, would pay off in the long run.

Between interning at CNMC and going to class, I worked as an after-school teacher at a local elementary school and, for a short time, had a job in retail to cover my bills. I used my experience at Children's to obtain a paid internship at the U.S. Environmental Protection Agency in the National Center for Environmental Research.

At the EPA, I gained a wealth of knowledge on issues in STEM, grant management, diversity and inclusion, and the effect of policies within the federal government on the research landscape. I helped develop grant solicitations and policy documents, and I supported a number of initiatives to help increase diversity in the research enterprise. These experiences would guide my trajectory.

I decided that instead of making incremental contributions to science, likely within a narrow scope, I wanted to develop a career around facilitating the nation's research and provide an environment for people from all walks of life to pursue careers in STEM.

While at the EPA, I completed my undergraduate degree in biology and transitioned into a master's program with a concentration in behavioral genetics.

In graduate school, I continued a full-time schedule. I would wake up at 5 a.m. to go to work, leave at midday to attend a class and return to work after my class concluded. I also taught two laboratory sections and conducted my thesis research late in the evenings and on the weekends. As a consequence of my schedule, I missed out on a lot of the extracurricular activities that sometimes accompany the life of a grad student. I barely knew my classmates or lab mate and mostly felt far removed from campus life. This sacrifice, however, was necessary to continue progressing outside the lab. Eventually, I completed my master's and moved on to work at the National Science Foundation, where I continued to grow my experience in federal science policy, STEM education, and diversity and inclusion.

My accumulated work experiences, in addition to my education, have made it possible for me to be in my current position as the science policy analyst at the American Society for Biochemistry and Molecular Biology. My goal continues to be to work on policies that positively impact science and contribute to a diverse STEM workforce, and I hope to continue to make strides to move these issues forward.

When I began college, I was naive not only about the workforce but also about what it would take to reach my career aspirations. My collected experiences have built on each other and have permitted me to gain skills relevant for different industries, as well as allowing me to be considered competitive enough to rival my peers. Balancing my education and career has not always been easy, but effectively accomplishing that balance has paid off in the long run.

Andre Porter (aporter@asbmb.org) is the science policy analyst in the public affairs department at the ASBMB.

Opening the doors to the Invisible College

By Rafael E. Luna

The Invisible College, a network of successful scientists working to help each other and mentor the next generation of investigators, has been in operation for centuries, serving to promulgate and advance the frontiers of science. Given the low numbers of underrepresented minorities in the biomedical research workforce, is it possible to usher a new generation of scientists into the Invisible College in order to accurately reflect the population demographics of the United States?

I first encountered the Invisible College as a student, having been fortunate to find a mentor who encouraged me to pursue my doctoral degree in the biomedical sciences.

He spent an inordinate amount of time guiding me, always allowing me to make mistakes and helping me to learn from them. As the first individual in my entire extended family to attend college, I was perplexed upon receiving his generosity.

One day when my mentor and I were working on a manuscript, I looked up from my laptop and stared into his eyes. "Why are you helping me?" I asked.

The question took him by surprise, and he remained silent for a few moments. He leaned back in his chair and grumbled in his customary manner. Then a smile surfaced on his countenance as he stared back at me with equal intensity.

"When I was a student, I had similar circumstances," he said "Someone mentored me, which laid the foundation for my success. Hence, I am part of a continuum of scientists helping the next generation. You are entering into this Invisible College, and you are charged to help others."

I was floored by his response. This was the moment in our mentor-mentee relationship in which I felt that I was part of something bigger than myself. From that day forth, I stopped doubting whether I was capable or smart enough to earn a doctorate. Every academic challenge became an opportunity to persevere and share the lessons I learned with younger mentees. I unearthed the key to success in the biomedical sciences, which is to place one foot in front of the other and connect with as many members of the Invisible College as possible. I continued along the trajectory, mentoring others and catalyzing their entry into this perennial stream.

I am honored to serve as executive director for the National Research Mentoring Network, which has laid the infrastructure for thousands of mentees to gain access to the Invisible College by linking with its members, promoting diversity and continuing the advancement of biomedical research in the U.S. We achieve this through strategic synergies among five NRMN cores: the administrative core at Boston College, the mentor training core at the University of Wisconsin-Madison, the mentorship and networking core at the University of North Texas Health Science Center, the professional development core at the University of Minnesota, and the research resources and outreach core at the Morehouse School of Medicine.

The American Society for Biochemistry and Molecular Biology is an NRMN scientific society partner, which entails building awareness of NRMN and the National Institutes of Health's Diversity Program Consortium's offerings among ASBMB members, collaborating to deliver NRMN and DPC programs and workshops, and supporting advancement of diverse and inclusive biomedical researchers and scholars.

NRMN opens the doors of the Invisible College not for the select few but for all. Learn more and become a member at nrmnet.net.

Rafael E. Luna (rafael.nrmn@bc.edu) is the executive director of the National Research Mentoring Network.

Considering a job in industry?

Insiders offer words of wisdom

We asked American Society for Biochemistry and Molecular Biology members who work in industry to offer advice and information to scientists who are considering or seeking industry jobs. These selected responses have been edited for clarity.

More than 60 percent of respondents formerly worked in academia. We asked what led them to make the switch to industry.

I wanted to work on projects leading to the clinic and higher salaries.

Bryan Thacker, scientist, TEGA Therapeutics

I switched because of excellent opportunity in industry. Also, I was forced to obtain 60 percent salary from grants in a 12-month hard-money appointment.

Michael Simonian, consultant, MHS Biotech Consulting

I did not want to stay a postdoc forever, and I needed a job but had no desire to start my own lab.

Vimbai M. Chikwana, associate research scientist, Dow Agrosciences

Working at Sloan–Kettering Institute for 16 years, I performed challenging and interesting research with stimulating colleagues. At Rutgers University during most of seven years, I taught six or seven different courses for undergraduate, graduate and medical students, and I had little time for focused research and few opportunities for collaboration with clinicians. In industry, without teaching obligations, my research and colleagues have been stimulating and rewarding.

Merry Sherman, chief executive officer, Mountain View Pharmaceuticals Inc.

With parallel appointments as an adjunct professor for the last approximately 30 years, I've been able to have my cake and eat it too.

Walter H. Moos, CEO, ShangPharma Innovation Inc. (semiretired)

Name one major difference between being a scientist in industry and being a scientist in academia.

Making a profit is necessary in industry.

Walt Shaw, CEO, Avanti Polar Lipids Inc.

In industry we work on many different subjects. In academia we are more focused on a given research subject. In industry, we are specialists in development processes and generalists about science. We know many things about different subjects but don't dig as deep as we would in academia. As far as I'm concerned, work is characterized in industry by a wide knowledge, due to the need for changing subject regularly, and in academia by a deep, advanced knowledge.

Stéphane Krief, principal investigator, Bioprojet Biotech

There is more focus in academia on research but a broader scope in industry.

Sheng-Jiun Wu, principal scientist, Janssen R&D

Independence is greater in academia.

Andrey Shaw, staff scientist, Genentech

Industry is more collaborative.

Wayne Fairbrother, director and senior staff scientist, Genentech/Roche

In industry, projects come and go. Don't get too attached to a specific project.

Mary Bossard, principal fellow, Nektar Therapeutics

Beyond your abilities in the lab, what skills do you most need to succeed in industry?

Writing, writing, writing! Not scientific writing but regulatory writing. Understanding the drug-development process (and in my case, drug/device or device). Adapting to inevitable layoffs and moving from one company to another (I have worked for seven different companies in 29 years).

Felicia R Cochran, associate director of regulatory and scientific affairs, CTI Clinical Trial & Consulting Services

Be a team player and set aside personal interests for the interest of the company; you need research speed and thoroughness.

Paul Neilsen, director of research and development, Echelon

Being able to move from project to project without getting all of the answers. Patience and a long-term horizon for success.

George Vlasuk, president and CEO, Navitor Pharmaceuticals Inc.

Ability to work as a team; be flexible, as the project priorities can change and they change rapidly with management changes. Constantly acquire new skills; stay current on technology.

Krishna Kodukula, executive-in-residence, managing partner and acting CEO, K2 Bio-Pharma Consulting LLC

People skills — the ability to communicate with people from different functions of the business with different levels of skills.

Nihmat Morjana, director, Siemens Healthineers

What's one piece of advice you'd give a student or academic who wants a career in industry?

Learn leadership and professional development skills. These are typically very distinct from those skills learned as a young Ph.D.

Eric Gumpricht, manager of research and science, Isagenix International LLC

Think twice, because today's pharma environment is terrible.

Gregory Kaczorowski, president and CEO, Kanalis Consulting LLC

Study hard and prepare yourself.

Kou-Wha Kuo, director of research center, G&E Herbal Biotechnology Co. Ltd.

Be flexible. Your scientific and other knowledge, skills and experience can be applied to many aspects of a business, especially a startup. Listen to Marketplace on National Public Radio.

George Quellhorst, associate director of research and development, Qiagen

Don't hesitate to leverage your knowledge and training, but keep the end user in mind.

David Vallari, technical support leader, Abbott Laboratories

Go for it, if your passion is applied science. Sometimes we do basic science to understand the process or a biological molecule that could be used downstream in a real-life application.

Sriharsa Pradhan, distinguished scientist, New England Biolabs Inc.

You will be able to maintain and grow the intellectual pursuits you learned as a student, but you need a high degree of flexibility in finding unique and useful ways to apply that knowledge. You should seize opportunities to expand your skills and knowledge, but that should be a goal in any science career.

Stephen Buxser, chief analyst, Select Bio Consult

Do not think jobs in industry are more stable. One still needs to work hard and excel to advance in industry.

J. Yun Tso, managing partner, JN Biosciences LLC

Don't close out options; if you are unclear, investigate both avenues.

Thomas W. Myers, senior director, Roche Molecular Systems

An individual should start a career in industry at a young age, perhaps immediately after a successful postdoc. There is a high importance on accommodating in the local corporate culture and moving as high as it is possible.

Gyula Varadi, vice president of research, Inpellis Inc.

To see respondents' complete answers to our industry questionnaire, go to asbmb.org/asbmbtoday.

Dressing professionally for women and

A well-fitting blue, black or gray suit is a reliable go-to for business formal occasions like interviews and important talks.

Wear dark flats or heels of less than three inches with a closed toe and a back. Comfort and versatility are key.

Wear a blouse or knit top modest enough so you can comfortably remove your jacket.

men: the job interview

A properly fitted blue, black or dark gray suit paired with a white, light blue or other subdued color of dress shirt are important articles of clothing for business formal occasions.

Opt for a conservative tie. An interview is most likely not the best time to showcase your personal style.

Your dress shoes should have thin soles. They should also be shined.

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10 real-world skills scientists bring to the workplace

By Diedre Ribbens

Think that a scientific education means you're limited to working in a lab your entire life? Think again! If you're considering a move away from the bench, your training as a researcher means you have tons of skills you can apply in a business environment. When you are preparing your application or interviewing for a nonresearch position, consider highlighting some of the valuable qualities embodied by those who conduct scientific investigation.

10. Teamwork and collaboration

Research is inherently a collaborative activity. It requires you to partner with your lab mates, your research mentor, other research groups and core facilities, among others. Business activities are collaborative too. Being able to outline your role and duties in a group project clearly, execute your tasks, report your progress and see how your piece fits into the bigger picture are all important teamwork skills you pick up while working in a research lab.

9. Mentoring

Many people who work in a lab end up with experience as mentors. As an undergraduate researcher, you may mentor newer students. As a graduate student or postdoctoral fellow, you mentor junior students at all levels. Forging relationships, giving guidance and managing your workload while helping others are all skills you're acquiring when you mentor. Mentoring is also important in a business context. Many companies have formal mentoring programs for their employees, in fact. Drawing attention to your experience as a mentor in the lab is a great way to demonstrate your compassion and leadership on your job applications.

8. Teaching

Being able to teach someone is another great skill many graduate students and postdoctoral fellows acquire. You have to have confidence in your knowledge of the subject and understand the subject on a deep enough level to explain it to a nonexpert and answer that person's questions. You also have to be able to tailor information to the learning styles of your students. Teaching also demonstrates patience. Including your teaching experience on your application will show that you have capability and that you're ready to apply it in a business setting.

7. Project management

In a lab, you're responsible for managing and planning your own experiments, estimating how long your work will take, and running simultaneous projects or experiments. The same concepts apply to business project management. If you can do all of that in the lab, you have demonstrable evidence that you can do it in the business world.

6. Independent learning

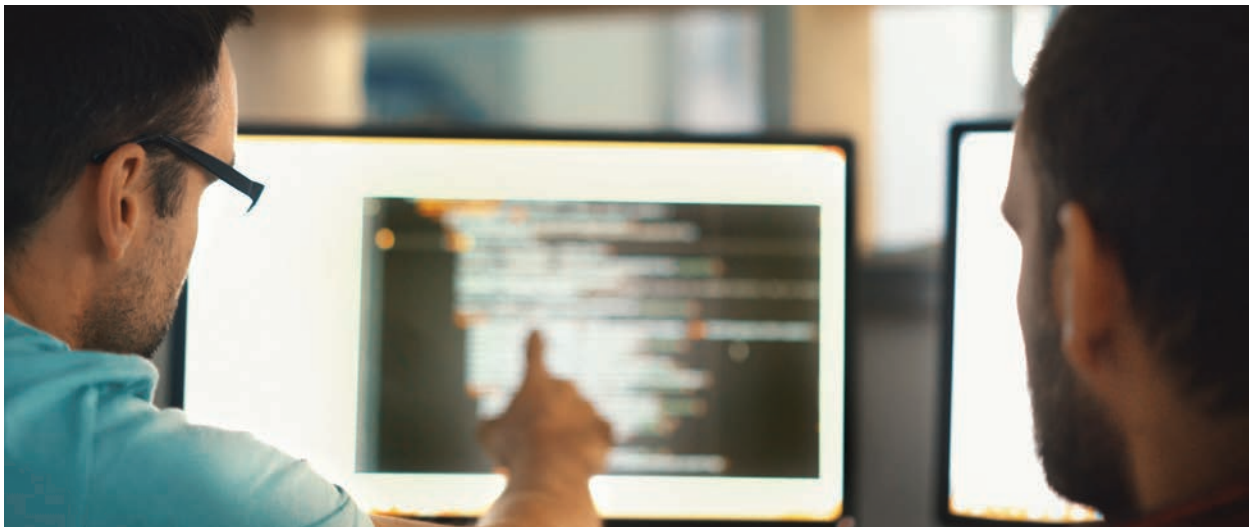
Most scientists naturally are driven to learn and are able to seek out information for themselves. Being self-directed in your learning and knowing where and how to find new knowledge is essential in any field. If you can motivate yourself to learn, you'll quickly catch up in your new business role. Additionally, when you're starting a new project, you're able to gain independence more quickly, showing your value to your new business team.

5. Clear and concise writing

Communicating your research almost always requires writing. As a scientist, you are trained to write in a way that conveys the important information without being overly verbose. You can organize your thoughts in a logical way to tell a story. Being able to write well can be applied to almost any profession, especially in the business world. As a bonus, scientists can write for a variety of audiences.

4. Designing amazing PowerPoint slides

Posters, research presentations, group meetings — the list of places your research intersects with a PowerPoint slide is endless. Being able to use PowerPoint and understanding the principles of creating a great presentation are incredibly valuable in the business world. Telling your story



while keeping your audience engaged is not always an easy feat with PowerPoint, and your doing so will enable you to win over the business world.

3. Public speaking

Another way of presenting your research is to get up in front of an audience and tell your story. Believe it or not, all of those times you were able to articulate your thoughts to a crowd were great practice for the business world. Oral presentations, leading meetings or even just voicing your opinion in a group are great examples of ways that your public speaking skills transfer outside of the lab environment.

2. Data organization and analysis

Being able to collect, organize and analyze data, as well as to draw connections between different pieces of information, are common to both science and business. As a scientist, you're practiced in this skill, so you can use it in almost any field, including business. Additionally, being able to manage and analyze large amounts of data using Excel, statistics and other tools can be very useful outside the lab.

1. Problem solving

Ah, the scientific method! A logical, organized approach to solving problems. News flash: Science is not the only field with problems to solve. There are tons of problems to solve in business contexts! As a scientist, your ability to identify and articulate the problem to be solved, select variables that affect the outcome, and methodically test solutions will make you stand out in a business environment.

Diedre Ribbens (diedre.johnson@gmail.com) is the ASBMB's careers blogger. She posts themed lists of job openings and advice columns each week at www.asbmb.org/careers/blog/. This piece originally ran on the blog in March 2017.

The power of productivity

By Diedre Ribbens

We all know those friends or colleagues who seem to have a mysterious ability to get work done — the classmate who graduates with his or her Ph.D. in a year ahead of everyone else or the co-worker who gets every project done ahead of schedule. Want to know the secret? It's likely that they have mastered the art of productivity. Here are tips, tricks and habits that you can use to boost your own productivity.

Building blocks of productivity

When you think of your most productive days, what characteristics did they have in common? You were probably feeling very motivated, focused and set on accomplishing a specific task. These are the building blocks of productivity: motivation, focus and goal setting. Let's take a closer look at each of these building blocks and ways to improve your ability to use them in your everyday workflow.

Motivation

It can be difficult to know how to motivate yourself. We all have some tasks we dislike and some we are excited to do. Many people find that their motivation waxes and wanes over the course of a day or a workweek. Believe it or not, you can influence your motivation and train yourself to stay more motivated more often.

First, people are motivated to do things they feel excited about over things they dread. Take charge of your workload and try to get your own work accomplished before helping out colleagues. Yes, it's good to be helpful in the workplace, but not at your own expense. You can do this by starting out each day with predetermined tasks rather than immediately checking your email and responding to the needs of others. You also can feel empowered to turn down requests for additional work that you honestly cannot accommodate or asking a co-worker to wait until you've finished your own tasks before providing them help with theirs. Are there any tasks you can delegate to a co-worker to free up your time to work on the bigger, more challenging project? Delegating tasks (when used appropriately) will help build rapport with colleagues and free you up to work on the things you're most motivated to accomplish.

Next, we all know that tight deadlines sometimes can create stress, but did you know that self-imposed deadlines can create just the right amount of stress to keep you motivated to finish a task? If you have a project or series of tasks for which there is no deadline, make one for yourself. If you're having a hard time starting a task that's not due for a long time, setting a deadline for checkpoints along the way also can help you stay motivated to work on it before it comes down to the wire.

This next tip seems counterintuitive, but I've found it to be true: Don't be afraid to leave tasks partially incomplete or questions unanswered. During graduate school, I was still competing as an endurance athlete, so there were many days I would leave the lab early to go train. During those long hours of training, I would ruminate over my thesis work in my head, thinking critically about data and experiments and hypotheses, and on more than one occasion, I had a huge breakthrough in my work. Leaving tasks unfinished forces your mind to dwell on them, and you'll either come up with great insights after getting some time and distance from your work, or you'll be motivated to pick up your unfinished task immediately when you do get back to work.

Finally, create some time every day for reflection about your day. Block out 30 minutes to sit quietly at the end of your day and think critically about how your day went. What were you excited about? What were you not excited about? Why did you feel that way? What did you do well, and what could you have done better? If you ask yourself these questions and give yourself honest answers, you'll feel motivated to take charge of your next day and start fresh by tackling the projects you're most excited about (or excited to do better).

Focus

Focus is one of the hardest things for most people to master, especially in a society filled with interruptions and distractions. Challenge yourself to work distraction-free for blocks of time. Start small by saying, "I'm going to spend 30 minutes reading this research paper." The first 10 minutes, you may be tempted to check email on your phone or reply to a new Facebook status update, but stay tough and don't give in. You'll be surprised at how much more focused you begin to feel and how much less tempted you become to give in to distraction. Experts say that ideally you should shoot for 90-minute intervals of work before allowing yourself a short break.

When you feel your focus slipping, take short breaks to get away from your work and change your location.

Simply getting up to get a snack can reinvigorate your mental energy, and spending five or 10 minutes doing so can save time in the long run compared with powering through slumps in focus and trying to get work done as you become increasingly distracted.

If focused work periods and short breaks aren't working, try to eliminate distractions. Can you use noise-canceling headphones to signal to co-workers that you should not be interrupted? Can you turn your phone on do-not-disturb mode, turn it off or lock it in a desk drawer? Some people use a special browser that prevents them from visiting social media or news sites. Set rules for yourself about how often you check email or social media, and block out time to do so throughout your day rather than continually checking them.

One way to make sure you start each day with focus is to lay out a to-do list with your tasks for each day in the week. Managing tasks with a computer program, such as Evernote or Microsoft Office, can help you maintain a little flexibility, since you can move and rearrange tasks as the week progresses while still tracking your progress. This improved my own productivity, especially in the lab. I learned from a postdoc how to chart out my week's experiments, anticipating when I would need certain pieces ready to move on to the next step, and I could manage my workflow so I was always busy but not overwhelmed on any given day. It also helped me remember which tasks I should be starting next so I could stay focused and on schedule.

It might seem strange, but three of the most important things you can do for focus don't actually involve working. Getting enough sleep each night and getting regular exercise are crucial for your mind to stay sharp. Also, limiting the number of hours you work will boost focus — you'll make the most of the hours you spend at work rather than spreading out tasks or letting your mind wander.

Goal setting

Learning how to set goals is an art. Some goals might be very broad and take months or years to complete, and some goals might be very narrow, more like tasks on a to-do list. Both short- and long-term goals are invaluable in maximizing your productivity. To set really awesome goals, you have to keep them SMART. SMART goals are specific, measurable, achievable, realistic and time-bound. If a goal doesn't have these five elements, it's going to be much harder to complete. If you have a larger, more long-term goal, consider breaking it up into several smaller goals and articulate the SMART elements for both the big-picture and small, stepping-stone goals. You want to be setting goals on a daily basis, which also will help improve your motivation and focus.

Each day, track how much time you spend doing a given task. This will help hold you accountable for your time (which can also help keep you focused) and help you set better goals in the future. If you know how long a certain task takes to complete, you'll be able to be more accurate in articulating the realistic and time-bound elements of your SMART goals.

Diedre Ribbens (diedre.johnson@gmail.com) is the ASBMB's careers blogger. She posts themed lists of job openings and advice columns each week at www.asbmb.org/careers/blog/. This piece originally ran on the blog in June 2016.

Informational interview tips

How to get the most from experts

An informational interview is a casual conversation with someone working in a career path that interests you. It gives you a chance to learn about the career path and get advice about entering the market from an experienced professional.

1. Keep it short.

You should be able to learn about the person's career path and current position over a brief phone call or over coffee.

2. Take this opportunity to practice your elevator pitch.

Put it in writing when you email the person to set up the informational interview. Then give it orally at the beginning of the interview itself. Providing information about yourself in this way will help the interviewee tailor information to meet your needs.

3. Prepare pointed questions.

This requires doing your homework — on both the person, their position and the company.

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Building your online brand

How to stand out from the crowd

Your brand is unique. Your online presence should express your skills, values and personality. Future employers and collaborators may do an online search before deciding to work with you. Your online brand is your virtual introduction and allows you to show who you are as a professional scientist. Here's how you can influence this information.

1. Create a LinkedIn profile.

This is your online resume. Make it compelling and accurate. Connect with people you've met, especially after conferences. Get a professional headshot.

2. Have a social media presence.

Overwhelmed? Choose one platform. Topics for posts can include conference speaker quotes, interesting results from new papers and photos from the lab.

3. Develop your own website.

Identify a free host and a template that you like. Your personal website doesn't need to be fancy, but you want it to be readable and inviting. Include a short mission statement.

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Beyond survival

Becoming emotionally resilient in academia

By Madeleine Hull, Jose Barral, Pamela Mertz & Joseph Provost

The academic environment is unique for many reasons; it not only cultivates growth and creativity but also gives academicians the opportunities and resources to educate and explore the world around us.

Unfortunately, these opportunities are not always unfettered. Academicians face failure regularly; no matter the effort, no matter the time invested, there is no guarantee of success. Things outside of our control can throw a wrench in an experiment, bringing us back to square one.

Over time, the expectation to produce outstanding results can cause stress to compound, sometimes yielding serious consequences. It has become increasingly important for us to be able to overcome adversity and embrace change in order to thrive in stressful environments.

By developing emotional resilience, we can be adaptable and equip ourselves with tools to manage the stressors we often face, as well as survive in an environment driven by competition and innovation.

Grit and perseverance

One of the wonderful things about being in academia is the independence we have for most day-to-day activities. We don a variety of hats: As scientists, we are fortunate to focus deeply on interesting problems; as educators, we work to change the lives of our students. Unfortunately, this environment also can foster challenging personality traits. This means we may be subjected to toxic environments at times. Surviving and even thriving in such an environment requires an assortment of approaches.

In Robert Sutton's book "The No Asshole Rule: Building a Civilized Workplace and Surviving One That Isn't," the author tells us that at times we all may be the type of personality described in the title, leaving others feeling worse about themselves. He also describes how to recognize this behavior and change a toxic climate in academia and business. Recognizing that we all may be "bad actors" can be a technique to help improve a challenging environment.

"Grit" and "perseverance" are trendy terms used to define a mechanism by which individuals can thrive when they bump against such people or groups in their careers.

We can learn a few lessons from the Navy Seals, who keep going even when faced with the most overwhelming circumstances. Eric Barker dug into the mentality of Seals training and wrote the post "A Navy Seal Explains the 8 Secrets to Grit and Resilience." Many of these secrets also can help academics.

One secret is about purpose and meaning. When deep into academic drama, it can be easy to forget why we became scientists and educators. As Barker puts it, "Without a good reason to keep pushing, we'll quit." It is essential to remind ourselves of these reasons; keeping them in focus as a touchstone can help maintain perspective when dirty looks and flaming emails threaten to consume our energy.

Talk to those who have been immersed in departmental or personal conflict; it is draining and too difficult at times to resolve. The energy is lost, and all aspects of one's career and personal life can suffer. Keeping perspective and understanding what your professional purpose and meaning are about may just keep things sane.

Another secret is to celebrate small wins. Both Barker and Sutton explain that finding a victory, no matter how minor, is something that helps one maintain a healthy attitude. The Navy Seal trainees have to go through a week as horrible as it sounds: hell week. One of the techniques they use to get through it is "the small victory." Barker quotes James Waters, a Seal platoon commander: "It feels good. You sit down, have a nice meal, and feel like everything's great." Then the torture begins again.

In "The No Asshole Rule," Sutton explains that these small victories are what you need to string together and share with others who also are suffering.

Also, taking control from bullies limits their domination and can lead to winning the battle. Sutton advises that standing up to the bully is not always effective.

Another approach is emotional detachment: the opposite of being passionately engaged. Emotional detachment means remaining aware of what is happening but removing oneself from the emotion of a stressful situation. Sutton describes how one person implemented a technique — originally used to survive capsizing while whitewater rafting — to make it through withering looks and slights during department meetings. The idea is to flow with the current rather than fight it, to relax and use your feet to push off from boulders. The person

thought about this technique when she was subjected to a room full of bullies. Once she remembered how to lift her feet and bounce from the critics, the emotional detachment became empowering, and that survival skill allowed her to undermine the negative behavior of others.

Simply leaving a bad environment is much harder for those in academia. Equipping ourselves with tools to survive, overcoming those who bully and act in degrading ways, and actually thriving are not simple.

Part of going with the flow requires us to be flexible, accepting and self-aware, regardless of our situation. By allowing ourselves to look at things from a distance, we are not only able to survive but to thrive.

Mindfulness

Mindfulness is one of many tools we can use to separate ourselves from toxic environments. Several lines of evidence suggest that people who practice mindfulness have increased resilience to various types of stress. But what exactly is mindfulness?

Put simply, it means being fully aware of the present.

If our daily routine is like a river, mindfulness allows us to stand at its banks and observe its flow. This means that we need to pause intentionally and disengage from our routines in order to turn our attention fully to the present moment.

Stopping what we are doing to focus on our breathing and our bodies or repeating a simple phrase are useful ways to exercise mindfulness. This allows us to experience our reality as it is at that precise location and time. We should try not to pay attention to our desires, our presumptions or our biases. We should passively experience and observe; we should go from doing to being.

Although this sounds simple, it requires effort and discipline on our part: We must remember to stop, step aside and practice mindfulness regularly. People experienced at practicing mindfulness state that the only wrong way of doing it is not to do it. In other words, as long as we get to practice a period of mindfulness on a regular basis, the frequency, setting and technique are not so important.

We would like to emphasize that although religious groups, including Buddhist monks and Christian ascetics, originated the practice of mindfulness, it does not necessarily have to include any religious or spiritual connotations.

So how does all this help us deal with the stress of academia on a day-to-day basis? Although mindfulness will not immediately result in a relaxed state — or any other special state or feeling, for that matter — it will allow us to accept the moment as it is in the present. We become aware of and acknowledge our emotions, both positive and negative. We realize

that whatever we are experiencing will not last forever.

When practiced in a disciplined, regular fashion, this awareness can help us gain knowledge of our true current skills and abilities, providing a stepping stone to move in the direction to attain fulfilling lives. In other words, we should not try to practice mindfulness solely for the sake of relieving stress. If practiced routinely, one benefit of mindfulness can be a more accepting and contented life.

We would like to point out that people who are experiencing significant stress, anxiety, sadness or grief should be encouraged to seek help from professional counselors, psychologists or psychiatrists. Practicing mindfulness may be conducive to fulfilling, satisfying and resilient lives, but under certain circumstances, it may be insufficient on its own.

Growth mindset

Adopting a growth mindset can help build emotional resilience and persistence. Carol Dweck, a Stanford University psychologist, developed the concept of the growth mindset and has written books and numerous articles on the subject. Someone with a growth mindset believes that abilities can be developed and that individuals can process mistakes and learn from them to improve in the future. For example, a person can be a successful scientist because he or she consistently puts in effort to improve; success isn't dependent on innate intelligence alone.

In contrast, someone with a fixed mindset judges situations based on innate ability, which is permanent. Individuals with a fixed mindset tend to run from difficulty. They are less likely to seek out opportunities that challenge them, as failure confirms self-beliefs. With a growth mindset, individuals can think about the process of achieving goals as being analogous to a marathon, not a sprint.

The growth mindset is applied in the education of children, and it is recommended that both parents and teachers praise the effort and progress of learning — not intelligence or just the final outcome. The premise is that this will result in kids who are hardy and resilient.

This idea of the growth mindset is important not just for students but also in the work environment. A study with Fortune 1000 companies evaluated whether each company had a fixed or a growth mindset. Results showed that employees who worked at a business structured on a growth mindset felt more empowered by their companies and committed to them. In these cases, the company valued innovation and creativity. In fixed-mindset companies, employees are more likely to be engaged in hostile practices like those "The No Asshole Rule" describes, such as not sharing valuable information with co-workers.

Parallels could be made to work environments for scientists. Placing more value on the process of scholarship rather than on just the desired outcome might create a healthier environment in academia. Grant-proposal submissions, instead of just funded projects, should be recognized. Research presentations at conferences and new collaborations should be acknowledged in addition to peer-reviewed publications. These are also examples of celebrating the small wins. Strong mentoring, including sharing valuable information with colleagues and providing sound advice, could lead to a better environment where more people can thrive.

Albert Einstein once said, "It's not that I'm so smart. It's just that I stay with problems longer." Emotional resilience enables us to stay with problems longer and not only have the passion and drive to find a solution but also make sure we have the tools to run the marathon, especially when things get challenging: grit, persistence, mindfulness and a growth mindset.

Major offenses? No magical answer

Resilience at its best can go only so far.

What if that person or environment is too much? How do you know when a situation or personal interactions have crossed the line? Being constantly confronted by an aggressor can take all of the energy from your career and impact your health.

Look for allies and ask a senior colleague for advice. If needed, find a supervisor or administrator who will put their foot down to stop, correct or even remove the offending person. However, you may find yourself isolated when looking for an ally or advocate. Politics and a self-preservation mode too often moderate the level of support from those who should come to your aid.

If the offender moves into racism, sexual harassment, or physical or mental intimidation, you must work with your supervisor, the Title IX coordinator or the human resources office.


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Using your science beyond the bench: nonresearch careers in academia

By Kathleen Goss

Those with a Ph.D. in the biomedical sciences seem to fall into one of two camps: you either love academia, or you can't wait to go somewhere else. Without reservation, I can say I have always been in the former camp. I love everything about academia — the campus environment, the intellectual stimulation and freedom, the students, the anticipation of a new year in August or September, and the joy of wrapping up a year in May or June.

When I made the decision not to be put forward for promotion and tenure four years ago (knowing it would very likely not be successful), I did so purposefully so that I could leave open the possibility of staying at my institution in some capacity. I wasn't sure what that would be, but after serving as a principal investigator for many years, I thought I had developed some transferable skills and knew I had developed many interests beyond the bench.

I was fortunate enough to land on my feet in an administrative position at my institution that I adore. In fact, it was as if I had been meant to do this all along. Using those transferable skills? You bet! Multitasking, bringing groups of people together, networking, effective communication, project management, writing, and on and on. And what about pursuing those nonresearch interests of mine? Absolutely. My role integrates all of the things that I cared about as a PI but

didn't have sufficient time or energy to pursue as much as I wanted, including science advocacy, teaching, program development, communications and outreach.

So I got lucky, but how common are these types of nonresearch positions in academia? It is hard to pinpoint the numbers with any certainty, but estimates suggest that 18 percent of positions filled by Ph.D. scientists are science-related nonresearch jobs (1). These include jobs in the private, government and nonprofit sectors as well as academia.

These types of positions can look very different from institution to institution and even within an institution. For example, there are many types of administrative positions that benefit from or even require a Ph.D. in the sciences, including pre- and post-awards grant administration, research administration, center/institute administration, faculty affairs and education (e.g., graduate or postdoctoral affairs). In fact, assistant or associate dean-level administrative roles often do not require the individual to be a faculty member, contrary to what it may seem.

Beyond administration, program and project management positions can be a good fit for a Ph.D.-level scientist, including leading projects in a focused research area or directing specific education programs, for example. Additionally, shared resources (aka core facilities) often have Ph.D. scientists as technical directors who manage the facilities, oversee personnel and budgets, and contribute to collaborative research projects. Some academic

CONTINUED ON PAGE 38

The cost of networking

By Melissa Vaught

We talk a lot about how networking is really important. And it is. Many collaborations, jobs, and other professional (and personal) opportunities arise out of connections made with others, often at conferences or local happy hours or any other number of meetups.

We often talk about the emotional and psychological challenges networking can hold for some of us. It can be exhausting for the introvert, uncomfortable for the shy, near panic-inducing for the socially anxious, overwhelming for the one with imposter syndrome.

Yet we don't often talk about the financial aspect of networking. And this is also an important consideration.

Sometimes events at conferences or organized by local groups are sponsored and free, which cuts down on the financial concern.

But a lot of informal networking happens locally or at meetings. "Let's meet for happy hour." "Why don't we continue this conversation over lunch?" "Hey, who's in town for the conference? Let's get together for dinner!" There are (good) reasons for this. Our time is limited, especially when we're traveling for work. Plus these can be more comfortable* settings that occur over meals or drinks.

But cost — and uncertainty about what to expect — can make these outings stressful. Conferences are often in expensive cities (and often in expensive parts of those cities). There are caps on how much institutions will reimburse for each meal, and most (if not all) don't reimburse the cost of alcohol. Academic institutions are notoriously slow in processing reimbursements. If the outing spins out of a local group or networking event, then there's likely no financial cover for an informal gathering; it's simply coming out of one's own pocket. Many in attendance — especially early-career folks — may have stretched finances.

If you're out with one or two students or postdocs, it's nice to pick up the tab (if you can afford it). It alleviates the financial pressure. I do this these days. Many of us have had professors or other established professionals pay for our coffee or dinner or drinks over the years, and paying it forward is one way to return the favor.

In a large, loosely associated group (e.g., people connecting for the first time), though, picking up the tab becomes less feasible. Singling out one or two people to cover may not be fair or comfortable for you or for them. So if you're organizing a meetup, please be mindful of cost — especially if you don't know everyone (or their financial position) well and especially if early-career folks are invited. Everyone may not be as comfortable with a big bill as you may be.

Sure, if someone's not comfortable with the prices, they can choose not to go or bail out at the door. But that means they're missing out on an opportunity. Again, we tell everyone that networking is crucial. So are we really just OK with excluding someone who can't afford it?

Alternatively, a person may choose to go but then be very stressed about accounting. They might try to be careful about what they order. The bill arrives and someone says, "Oh, let's just make it easy and split it evenly." The person who's not comfortable with that arrangement may be too embarrassed to speak up. Now this chance to hang out with some inter-

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institutions use doctoral-level scientists on their communications teams to promote their scientific accomplishments to a wide range of audiences. And finally, some institutions are hiring Ph.D.-trained scientists in their career centers. Who better to help guide future scientists than those who have lived it?

Knowing about these different positions is a necessary first step, but to get a feel for the type of role that is right for you, you will have to explore them carefully. If you are a student or fellow, try to find individuals who have jobs like these at your institution and conduct an informational interview (hint: almost no one says no to this). What do they do every day? How much or little are they using their science background? What is the best part of their job? The worst? Do they work on a team? And if so, do they enjoy it? How is the work-life balance?

With this information in hand and a strong sense of what your ideal job would be, it's time to find available positions. Some of these jobs will be listed where you are finding other careers for scientists, but you may need to explore individual institutions' job postings as well as sites like HigherEdJobs.com. Job titles can be confusing and daunting (and vary immensely among institution and even units within institutions), which means you need to read the job description and qualification requirements very carefully. And if you have questions, don't hesitate to ask.

During the application and interview process, it's important to sell yourself and clearly describe the talents and experience you will bring to the table. This is especially important if this will be your first job outside of research, since you may not have much experience that seems directly relevant. Furthermore, being prepared, asking good questions and showcasing your genuine interest and excitement about the position will go a long way toward demonstrating that you are ready for the transition from research. Explain clearly and concisely how this role is a great fit for you. The truth is they should want to find the best fit for the open position as much as you want to find the best fit for you.

And what is the outlook for these types of nonresearch careers in academia for Ph.D. scientists? Again, it is difficult to put numbers on it, but my sense — and the sense of many of my colleagues — is that institutions are putting more value on what Ph.Ds. can bring to all aspects of the academic environment. From administration to career advising to program management, more and more of these jobs seem to be available. That's good news for academia and really good news for you if this type of career is what you are looking for.

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esting people, to talk, to network and maybe to have some fun has turned into a source of anxiety. Beyond this one time, it might influence this person's stress level or willingness to join in the next opportunity that comes along.

This isn't just some hypothetical scenario. It's not just an exercise in empathy. I know how this feels, because I've been this person. I've made the mental calculations over the course of the evening. I've discretely (or at least, I hoped it was discretely) double-checked my account balance or made a transfer under the table. I haven't had this experience for a few years. Yet just thinking about this — much less writing about it publicly — still induces that tight feeling in my chest. I can still feel that stress keenly. And it can even trigger a feeling of shame, a worry that even today people will think less of me because I was in such a financially precarious position.

So on behalf of past me and others who have financial worries, please consider the cost of the informal events you plan and how it might stress or exclude those who've been invited.

And to all those who picked up my bill over the years, thank you for that kindness.

** Certain settings can be challenging for individuals for a variety of reasons. Some bars and restaurants present obstacles to those with mobility issues. Loud restaurants present a challenge if someone has a hearing impairment. Being surrounded by alcohol and those consuming it can be uncomfortable for many different reasons (from those who don't drink for health or religious reasons to those who've been in unpleasant or even dangerous situations where drinking was involved). When organizing outings, try to be mindful that your comfortable setting might be uncomfortable for someone else.*

Melissa Vaught (vaughtmd@gmail.com) is a scientific editor with Medical & Science Computing, LLC, contracted to the National Institutes of Health. This column originally appeared in her blog, Ever on and on, at biochembelle.com. The views expressed here are personal and do not necessarily reflect the views of the National Institutes of Health or the U.S. Department of Health and Human Services.

Fold your own pep talk

As you work to develop a robust CV, scroll through countless job descriptions and perfect a cover letter no PI or HR director could overlook, how can all you job-seeking students, postdocs and professionals stay motivated?

A pep talk is a simple place to start.

In "The Science of Pep Talks" (Harvard Business Review, July–Aug. 2017), Daniel McGinn suggests a formula for encouragement. "Direction giving, expressions of empathy, and meaning making" are components of true motivation, he writes.

Inspired by nostalgia and McGinn's article, ASBMB Today staff created this origami activity. Cut it out, fold it, and keep it on your desk. These classic reminders to persevere might not land you your dream job, but maybe they'll inspire you to keep trying. After all, we all start somewhere.

For an illustration and detailed instructions on how to fold a paper fortune teller, visit: http://bit.ly/2ucNG46.

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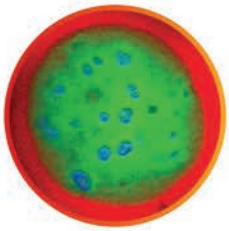

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Reminder: ASBMB members save on meeting registration.

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Project swap

By Russell D'Souza

Science always has intrigued me. In a high school chemistry class, I was taught that an atom was the smallest constituent of matter. I remember getting home from school and spreading common salt on the kitchen table to observe the particles using a pair of binoculars. I was fascinated by biology and chemistry combined, and I became interested in the functioning and mechanisms of biological molecules. I completed a bachelor's degree in chemistry and a master's degree in biotechnology from reputable institutions in India. I hoped I was ready to take on the role of a successful biochemist.

I landed my first job at a major pharmaceutical company in Mumbai. I joined the drug metabolism and pharmacokinetics department and was responsible for performing cell-based assays to determine the efficacy of small molecules. I was happy and settled well in my new laboratory.

After a year or so, I decided I needed to expand my knowledge, and I applied for a graduate program in the U.S. After rejections from several universities, I was admitted to the biochemistry and molecular biology program at Wayne State University School of Medicine. I was ecstatic!

The first year entailed rigorous coursework and qualifying examinations, which I cleared comfortably. I had made up my mind about joining a laboratory, so I did not perform the mandatory laboratory rotations. I was given a project early in my second year to study polymorphisms in a human assembly factor that aids in the assembly of the mitochondrial ATP synthase in yeast. It was a subject without much literature. I thought I'd be a pioneer in the field. This notion brought about the project's downfall.

We initially identified 10 polymorphisms we were to study in our yeast system. However, we never got past the first two missense mutations. Every time we expressed the human gene in yeast, we observed different results. We performed the experiments again and again but failed to get consistent results. We devoted almost a year to working on two of the 10 polymorphisms with no real data in hand. I was almost finishing my third year of graduate studies, and I had nothing but a few enzyme assays and western blotting results. I began to realize these polymorphisms that I was eager to characterize might be of no value, since there was no human pathological phenotype reported.

I began to doubt myself. I wondered if I had the potential to be what I had hoped. At the low point in my graduate career, emotionally and scientifically, I was almost ready to quit.

The saving grace was my graduate mentor and my departmental graduate committee. Being too far into the program, I was told to hang in there. I sat down with the graduate committee, and we decided on a smaller project that would help me graduate. This involved studying mutations in alpha and beta subunits of the mitochondrial ATP synthase, again in yeast. Again, I didn't know what to expect. I started by doing a literature survey of this area. It was my good fortune that plenty of studies on the bacterial ATP synthase were similar to my new project. They gave me a general idea of the results to be expected.

Suddenly, I had renewed hope. I began performing a battery of biochemical tests on these yeast mutants, and we came across phenotypical characteristics that had not been observed or reported before. Somehow, we began to fix the pieces of the puzzle in the new project, a process that had seemed so arduous during my previous one. I began reading a lot more and started to design some experiments. I was an entirely different person after completing my new project. I finally graduated in the summer of 2016.

I think about what I could have done differently. I've learned that reading the scientific literature is an important part of graduate life. We get so blinded by a new project that we do not make an effort to find out if similar work is out there and what questions it addresses. Unexplored areas of research may provide breakthroughs, but you have to ask the right questions. I also learned not to fear communicating my thoughts about my projects with my peers. My advice is to talk to your committee or senior graduate students and ask for their suggestions. Identify setbacks early, and back off when things go awry. There's no point in going ahead with something that's a dead end.

At times I still wonder about the possible outcomes of my second project if I had begun with it. It had so many avenues to explore, but I couldn't do them all; it was time for me to graduate. Could an earlier project change have saved me a year in graduate school? Maybe. In retrospect, I have absolutely no regrets about my choices. I mean, this is science. Things don't necessarily work out the way you want them to.

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A new career in retirement: from biochemist to novelist

By Robert L. Switzer

After retirement, what next?

Retirement from an active career in science often presents a life crisis. The last research grant is expired, its funds depleted; the lab is closed, emptied and being remodeled for a younger colleague. Now what? Most scientists are intensely — even passionately — engaged in their work. The retiree needs a new focus for his or her creative energy. But what?

This is the dilemma I faced in 2008 when I closed my lab at age 68 after 40 years of research and education in biochemistry and microbiology at the University of Illinois at Urbana-Champaign. I had approached retirement cautiously. I moved to emeritus status and gave up teaching in 2002 but continued to do grant-supported research for six more years. These last years were rewarding ones. We solved many — never all, of course — of my outstanding research problems, and I loved working with my last students and postdocs. I knew that I would miss research, but I also had to admit that my most imaginative years were behind me and it was time to make room for new faculty.

Many retired biochemists seek to continue their research programs, but in an era of intense competition for grant funds, this is increasingly difficult. Others turn to education, public service or work in the scientific for-profit sector. These are all good solutions to the retiree's need for new creative activities, but my wife Bonnie's midlife switch from elementary teaching to a successful career as an artist inspired my return to a long-dormant love of creative writing.

I had written a few short stories while in graduate school but then was far too busy to write anything other than grant applications and research papers. I began preparing for my new "career" during the last six years of research, when relief from teaching gave me more time to write. I started working on a memoir about family farming.

How did my career switch turn out? Better than I expected. While I haven't made significant income or appeared on any best-seller lists, I have published some of my writing and I have been having a lot of fun.

Develop your craft

The style of writing used in scientific papers requires extreme compression, information-dense sentences, heavy use of specialized jargon and a frequent use of the passive voice. These habits must be discarded in creative writing. One must learn to use vivid metaphors and varied sentence structure, write dialogue, create lively characters and vivid scenes, and become an entertaining storyteller. You can learn this by reading good fiction writers, by studying books on writing and by participating in workshops — but above all, by writing, revising, writing and revising.

I was too impatient to take formal workshops or classes, but I did benefit greatly from joining an excellent Champaign-Urbana fiction writers workshop. I was welcomed into a group of active writers, most of them published authors of fiction, creative nonfiction and poetry, who meet weekly to read and critique one another's work. Their reviews of my work were searching and critical but very constructive. I began writing fiction with short stories before switching to longer narratives. Whatever you write, it is important to share it with other creative people and to respond to their suggestions. One relevant lesson I learned is that non-scientist readers often have a deer-in-the-headlights response when scientific concepts are introduced. Keep it simple. Metaphors are valuable. For example, I used injured workers on an automobile assembly line to illustrate the effects of mutation in the genes for enzymatic steps in biosynthetic pathways.

Write what you know

This mantra among writers and teachers of writing is good advice. Writing from your own knowledge and life experiences gives your work authenticity and sincerity. Besides, it's easier than researching an entirely foreign topic.

For my first attempt, I chose to write a memoir about the dramatic decline of small family-operated farms in America, using the example of the farm where I grew up, which had been in the family since 1916. The result, "A Family Farm: Life on an Illinois Dairy Farm," was published by Columbia College Chicago Press in 2012. Memoir writing is a good way

to start. Most of us have an interesting life story to tell — unusual origins, difficulties overcome. With a memoir, the plot and characters are supplied by real life. All the writer has to do (and it's a lot) is bring the characters and scenes to life and move the narrative along in an engaging manner.

I have written three novels and am working on a fourth, but my first published novel, "The Lady Professor" (published in July 2017 by Bedazzled Ink Publishing, a small independent press in California), is also an example of writing what I know. The novel deals with several themes: the difficulties faced by women who sought careers in science and academic life in the first half of the 20th century, an attempt to show the lay reader what it is really like to do science, a woman who has the courage to take on controversial subjects, and a hushed-up case of scientific misconduct. Oh, yes, there's a love story too! It's not science fiction, but what Carl Djerassi, another scientist turned fiction writer, called "science in fiction."

Expect rejection — lots of it

Scientific publishing is completely unlike the publishing of creative writing. Nearly all my research papers were accepted upon submission. Most editors required revisions, sometimes extensive revisions, but the papers eventually were published. The scientific reviews were thorough and detailed. On the other hand, I have written more than two dozen short stories; I have only published one of them, but I have lots of rejections! Small literary magazines (which do not pay royalties) have many submissions on their slush piles. Rejection is often no more than a curt "not for us." Reasons are rarely given.

The publication of novels is even more difficult. Publishers have to make enough money from sales to survive. They want authors with established reputations and high recognition or writers of popular genre fiction, such as science fiction, fantasy, detective stories or romances. Why take a chance on an unknown retired scientist with literary pretentions?

I was incredibly lucky to find publishers for two of my books. In both cases, I was successful because they were small publishers whose areas of interest fit very closely with the subject matter of the books. "A Family Farm" was published by a now-closed academic press that was especially interested in American social geography. The publishers of "The Lady Professor" had announced they were interested in novels featuring strong, interesting women characters. It is important to research publishers' mission statements to find good matches. Even so, expect many rejections. Don't bother with the big publishing houses unless you know you have a blockbuster novel and a professional literary agent.

Enjoy your writing

Writing is not a 9-to-5 job. Few creative writers can work at it for long days every day as most scientists work at their profession. However, it is valuable to have a routine in a quiet, uninterrupted place to write and revise. The biochemistry department at Illinois has kindly let me keep my office. I work there in the weekday forenoons and early afternoons, interrupted by a swim in the university pool and lunch. When the writing is flowing, I work longer hours. When I'm stuck, it helps to walk, swim or work in our yard, mulling over plot ideas, bits of dialogue, phrases and word choices. I find it helpful to interrupt the day's writing when I have a good idea of what will come next — not when I'm against a blank wall.

Creative writing can be frustrating. Expect dry spells. But when it is going well, when the story flows onto the page and the characters come to life and talk to you, you will experience the joy of creation. Don't forget why you are doing this — not for money (you are unlikely to make much), not even necessarily to get your work published. You are doing it because you are drawn to creativity. A retiree usually has the financial security and leisure time to write for the sheer joy of it, even if you only share your work with family and friends. Be a storyteller. Have fun.

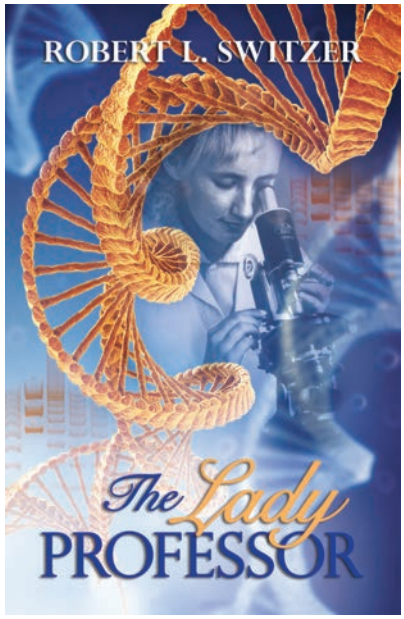

IMAGE COURTESY OF BEDAZZLED INK PUBLISHING

Robert L. Switzer's first published novel, "The Lady Professor," addresses multiple themes, including the difficulties faced by women who sought careers in science and academic life in the first half of the 20th century.

Of course, many retirees — probably most from a life in science — will not become writers. The broader conclusion I draw from my experience is that retirement is not to be dreaded. Rather, it is an opportunity to awaken dormant interests and talents, a time for new growth and self-discovery, an opening to a more relaxed second career.

Robert L. Switzer (rswitzer@illinois.edu) is professor emeritus of biochemistry at the University of Illinois Urbana-Champaign. His novel "The Lady Professor" is available from Bedazzled Ink Publishing and Amazon.com.

Disappointed — by cancer

By Jennifer DuBois

After spending a day with a bad cold and a pounding headache, I found myself standing in the shower at 1 a.m. rinsing out the drainage from a ruptured eardrum.

It was the sort of thing I'd comforted my toddler through numerous times. I could hardly believe my robust adult immune system had succumbed to a little kid's ailment — an ear infection!

I was scheduled to leave town for the next week on a series of seminar visits and figured an immediate trip to the doctor's office was warranted. My nurse-clinician, Katie, prescribed amoxicillin. She also gently suggested I go get that key lime-shaped thing lodged in my right breast — the one I had mentioned noticing about a month before — checked out and wrote an order for a mammogram. It was probably nothing, probably just a cyst, she said, but just to be safe, I should get it looked at right away. And the radiology department had really good, free coffee — so why not stop in on the way to work?

I set the mammogram order aside and went on my seminar trip, feeling around the bloating key lime while sitting in my hotel room, though I was still pretty sure it was just a cyst. I promptly scheduled a trip to the radiology department after my return and enjoyed a free chai latte in the ladies-only waiting room, wearing a fluffy pink robe. This wasn't so bad, I thought.

I was called into the exam room. As a biochemist and spectroscopist by training, the mammography machine to me seemed strangely clunky and ill-designed. A spritely young woman posed me like a Greek statue while she squashed flesh between paddles, first left, then right, each time instructing me not to breathe. She would not read the mammogram herself, but she assured me the radiologist would before I went home that day.

She sent me back out to the waiting room, but before I could get a refill on the free latte, I was unexpectedly called into the next room for an ultrasound. A mother of three, I was very familiar with this device, though I had never had it applied above the waist.

The radiologist introduced himself and said the mammogram warranted some follow-up. He rolled the instrument's paddle around and over and over my right breast — stopping and taking images, measuring, and uttering the occasional "hmm" or asking the technician to take down a number.

After about 15 quiet minutes of this, I asked, "So, doc, what is it — boy or girl?" I winced and immediately wondered how many nervous women had made the same joke. He looked me in the eye. He knew I was a scientist, and he discerned my preference for technical descriptions, which he proceeded to give. But the way he summed it up was far more memorable: "You have something inside you which is big and mean. We will need the biopsy for sure, but what you have is almost certainly cancer. I am so sorry to give you this news."

In the dressing room, where I changed out of the fluffy pink robe, I texted my husband that one word: "cancer."

In biochemistry circles as well as among the general public, we have become accustomed to the idea that cancer is not one but rather many diseases. But still, the word and the strangely unitary diagnosis persists. At that moment, I was not sure whether I was facing merely a highly complicated wart removal or something far more difficult and life-threatening. All I had to go on was that word, "cancer."

It was with unexpected excitement that I scheduled the biopsy that would give me a more specific diagnosis for the next day. I felt excitement because, as a biochemist, I expected the biopsy and its analysis to give me concrete answers while putting the awesome power of my field on full display. I had come of age during the era in which major cell-signaling pathways were unraveled; the human genome sequenced; databases of single-nucleotide polymorphisms assembled; and microarray, high-resolution mass spectroscopy and chemical genetics technologies blossomed. I was looking forward to seeing the pile of data that my biopsy would produce.

So how vast was the microarray database to which my tumor cells were compared? Actually, microarray data were not measured. How many PCRs were run? None. How many biomarkers were assayed? 30? 40? Try three, all by simple immunohistochemical stains painted on the surfaces of the excised masses.

Of those three markers, only two have any real treatment potential: overexpressed estrogen receptor (ER for short) or epidermal growth factor receptor, or EGFR. Even now that I am in the treatment phase, I have had no blood-borne markers, no circulating tumor cells assayed. The efficacy of my treatment is being assessed only statistically — by comparing me to the thousands of others who have

COURTESY OF KELLY GORHAM

Jennifer DuBois works with senior Ph.D. student Arianna Celis, who says, "We take a lot of joy in what we do and in each other."

received the same chemotherapy regimen before me.

Half of that regimen consists of doxorubicin (brand name Adriamycin), an anthracycline-based natural product from Streptomyces that initially received Food and Drug Administration approval in 1974. In my lab, we have been studying part of the biosynthetic pathway of its precursor compound, in part because of the importance of its use in a decidedly nonmedicinal application: breaking down wood pulp (1).

My new graduate student demonstrated its oxidizing power to me in stomach-churning fashion when she brought a test tube full of the sickly red Adriamycin core mixed with what looked like melted plastic. She had been attempting to measure the redox potential of her solution with an epoxy-coated electrode, and the precursor compound had dissolved the coating clean off the underlying glass.

And here I am, having 84 milligrams of this nasty stuff pumped into me by a special, personal-protective-equipment-clad oncology nurse every two weeks!

The second chemotherapeutic I get is Cytoxan, a cyclophosphamide DNA alkylator with FDA approval dating to 1959.

This was a far cry from the personalized medicine I had expected. What had become of all those fabulous papers, talks and poster sessions I'd seen over the years? It dawned on me that my initial, gut response to my cancer diagnosis and treatment plan had not been so much fear or dread but rather a surprising sense of professional disappointment.

But that's only the first half of the story.

My biopsied (and now surgically removed) tumor and lymph nodes turned out to be positive for one of those three biomarkers: EGFR, better known in oncology circles by its gene locus name, HER2 (2). Seminal discoveries related to HER2 in the mid-1980s made by Dennis Slamon and Stuart Aaronson of the University of California, Los Angeles, and Icahn Mount Sinai schools of medicine, respectively, linked its overexpression to rapid cell proliferation in about 25 percent of breast cancers. I remember learning about this way back in the mid-1990s in an undergraduate class I took called "Oncogenes."

Antibody-based, anti-HER2 therapeutics subsequently were developed by Genentech, eventually receiving FDA approval in 2006. The resulting drug, marketed as Herceptin, has been a game-changer for people like me with a diagnosis of highly aggressive, HER2-overexpressing (Her2+) breast tumors. Given after or in combination with conventional cytotoxic chemotherapeutics, Herceptin has had impressive, even fully curative and recurrence-free outcomes for patients like me who just a short time ago would have had very much darker prospects.

In 2012, a second monoclonal antibody (pertuzumab, marketed as Perjeta) was approved for use against Her2+ cancers.

In the meantime, a series of other cancers — of the ovary, endometrium, bladder, lung, colon, head, neck and esophagus — have been shown to overexpress HER2 and are consequently susceptible to targeted immunotherapies like Herceptin and Perjeta. Along with Gleevec, the first targeted cancer therapy to receive

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Schooled (and steeled) by invisible illness

By Erica Avery

I spent my 20th birthday in the emergency room. My friends had planned a festive breakfast and matching outfits, but at 5 a.m. I was lying in my bed in agony thinking, "If I can get through my 8 a.m. biochemistry lab, then I'll go to the ER." But I couldn't wait. At the hospital, every time I repeated my date of birth to a nurse, I waited for the reluctant "Oh … well, happy birthday …" as I lay there high on pain killers and on so much muscle relaxant I was choking on my own saliva.

Two years earlier, in my first month as an undergraduate, I'd woken up one morning with pain in my right elbow. It hurt too much to take notes in genetics class — I thought maybe I'd slept on it wrong. The pain got worse and rapidly spread to every inch of my body; then came fatigue, allodynia, cognitive dysfunctions, irritable bowel, sleep disorder, depression and other symptoms.

Eventually, I was passing out, losing weight from not eating and ultimately bedridden. My life came to a screeching halt; I was beyond scared. I wondered if I had multiple sclerosis, ankylosing spondylitis, lupus, even osteosarcoma, or if I was just going insane. I felt isolated and helpless.

Eight months after that initial pain and after every test imaginable, I was diagnosed with fibromyalgia syndrome. It was a relief to have an answer, even if it wasn't exactly good news. Incurable and chronic, fibromyalgia literally means "pain in muscles and fibrous tissues" — its hallmark symptom. Little is known about fibro, and drugs barely take the edge off. I would never be the same again.

I'd seen commercials for Lyrica (the drug I'm on now), so the diagnosis didn't surprise me. I knew it as "overactive nerves" that caused pain, fatigue and overall sensory amplification, as described on TV, but my idea and my experience couldn't have been more different. I thought it meant aches here and there, not this unyielding hell. My physical therapist described it as a "never-ending migraine all over your body, plus all the other symptoms." Moreover, fatigue doesn't mean "I'm tired." Fatigue means "I feel like I just got hit by a bus after running a marathon when I haven't slept in a week." While learning gas laws in freshman chemistry, my eyes suddenly couldn't focus on the equations on the board; I couldn't control my vision. I left and called my mother, who discovered that fatigue even affects the tiny muscles in the back of the eye.

Medicine's best guess is that fibromyalgia's onset is caused by some trauma — abuse, a car accident, chronic stress — that makes the nervous system go haywire. There exists a high comorbidity with post-traumatic stress disorder. Also, 90 percent of patients are women, with an average age of onset of about 40.

Doctors don't tell you that pain and fatigue come with more obscure symptoms that are just as severe. The brain fog, memory loss and speech impairment made me feel like I had dementia. In the car, I'd forget where I was going. In public, I'd forget how I got there or who I was with. I'd fumble over words midsentence, forget what I was saying entirely or forget whole conversations. I couldn't think or concentrate. Initially, I asked my doctor what treatment options there were for fibro fog, and he responded, "What's fibro fog? I've never heard of that." Through my own research, I found that lecithin supplements — which predominantly contain phospholipids — improve cognitive function.

I was just on my own, figuring out the real world and adulthood as a college freshman, when suddenly I didn't think I'd get through a degree. I was in crisis mode. I couldn't take care of myself.

But then I found the fight in me. My muscles don't work properly; they're weak, stiff and painful beyond words, but I learned to walk again when I could barely cross a room. I thought about my mother's numerous miscarriages in her struggle to have a family. I thought about my grandfather's Purple Heart, which I later had tattooed on my back in the spot where the sniper round left his body, to tell myself not to let suffering consume me. Driven by their resolve, I found that redeveloping endurance and strength in my body seemed attainable.

I've endured judgment, criticism, misunderstanding and even discrimination. When my speech was impaired in a professor's office, I asked, "Do you understand what I'm trying to say?" To which she replied, "No, because you're a college student who can't even complete your sentences." Sophomore year, my boyfriend broke up with me, saying, "I can't handle that you're sick." When I couldn't finish an experiment because I had severe sero-

tonin poisoning after starting the drug Cymbalta, my roommate called me irresponsible and disorganized. Meanwhile, I began having seizures. She said I was a burden, and I felt guilty and sorry for her as I vomited from the drug's side effects.

During a conversation with my rheumatologist, I used the word "disability." He looked at me and said, "You're not disabled. It's not like you have arthritis," and wouldn't sign paperwork allowing the university's public safety officers to transport me to class. I once explained to an acquaintance how my pathology means my muscles get stiff without provocation in a way healthy muscles don't; he responded, "You think you've got it bad, my shoulders are actually like rocks" — comparing his stress and tension to my disease.

PHOTO COURTESY OF ERICA AVERY

On her 22nd birthday, Erica Avery posed outside Johns Hopkins Hospital in the same Batman T-shirt she was wearing when she was hospitalized for fibromyalgia symptoms two years before.

Fibromyalgia affects up to a whopping 8 percent of Americans, but because we look normal, many people are clueless, and some don't even believe it's real. There's no test for it. The diagnosis is based on symptoms. This doesn't mean there isn't a biomarker for which a test could eventually be developed; it means people lack empathy.

I am grateful for those who've been truly kind. A professor once reassured me, "Refusing special treatment isn't the way to beat this. Accepting help isn't giving up." There's a PI with an autoimmune disease of her own, a yoga teacher who is a fellow fibro patient, and a best friend who thoroughly understands how to take my symptoms into consideration without pitying me. Complete strangers have offered me tea, phone numbers, books to read, words of encouragement and prolonged hugs and shoulders to cry on when I broke down in a support group. "I know you can still be happy" are the words that stay with me.

I've adapted to a new way of living. I cut off all my hair because the nerve pain was unbearable when I lifted my arms to wash or brush it. I fight like Hercules just to get out of bed every morning — that's my impossible labor. Once-mundane tasks like taking a shower leave me out of breath.

To meet my needs, I now operate at my own pace. My MRI showed the postural defects caused by weak and tight muscles that pulled out the curvature in the vertebra of my neck, a condition known as "military neck." To minimize flares, I take the bus, because the posture needed for driving affects muscle tension, causing swelling in my occipital nerves. I receive regular massages and often interrupt my days to go to physical therapy or at least do some stretches in between tasks.

I bring my fight to the lab every day; this disability makes me a better student. My unique perspective as a patient and scientist gives me an advantage. I know what it's like to desperately need answers and to have one's quality of life depend on them. Every day with a mysterious pathology of my own, I experience firsthand why research is important and how there's still so much we don't know. I rotated in a lab that studied skeletal muscle physiology and couldn't help but wonder what was happening with mine. When I first learned how mitochondria produce energy, having mitochondrial dysfunction of my own made me realize how much can go wrong. I appreciated just how my CoQ10, alpha lipoic acid and malate supplements help my mitos. I didn't just know the facts; I lived them.

I've found my own way of doing things, and whatever the task, I've made it work, just like writing a new protocol. Because of my body's limits, I've learned to keep trying and figuring out new approaches as we do in the lab after setbacks. Getting around problems and being patient but tenacious with experiments is something I learned first with my body. I've been troubleshooting my daily routine for years with supplements and medications, diets, exercises and other therapies. I've tried acupuncture, hyperbaric oxygen chambers and sensory deprivation salt float tanks — I've even been to hypnotists, reiki healers, shamans and mediums.

With an invisible illness, I must communicate effectively to people who will never fully understand, just as scientists often do. For my undergrad senior seminar class, we had to do 45-minute presentations from a

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FDA approval (2001), these drugs have revolutionized treatments for those lucky enough to have cancers that are vulnerable to them.

Gleevec, developed by Novartis, represents a brilliant success story for small-molecule medicinal chemistry. It targets the unnatural, cell-proliferation-associated tyrosine kinase BCR-ABL, which forms when a piece of chromosome 22 fuses to the end of chromosome 9 (generating the so-called "Philadelphia chromosome"). Like Herceptin and Perjeta, Gleevec has been nothing short of a wonder drug, in this case for patients with forms of leukemia that previously would have left little cause for hope.

As amazing as these targeted therapies are, we may still ask why there aren't more of them. By the same token, why, with so many stunning advancements in diagnostics, aren't these methods more widely applied?

My oncologist suggested that diagnostics generally are not used unless they are associated directly with a specific treatment option, of which there are still just a few. And with the time involved in translating basic discovery through a sharply winnowed pipeline into a safe, well-vetted treatment (about 20 years in the case of both Herceptin and Gleevec), we should expect such treatments to emerge at a slow pace.

So what's a scientist working on medically relevant basic research to do?

Be patient. Recognize that translational research and medicine will catch up eventually with, and fully exploit, the explosive pace of discovery that molecular and cellular biology has enjoyed for the past 40 years. Science may be lapping medicine for the time being, but that won't always be the case. In the meantime, we need to keep working to make a difference for the millions of people who still await a cure.

It's now two months on from the ear infection that led me to a diagnosis of breast cancer. A few days ago, I had a dream. I was standing on a curb when a red double-decker bus, the kind you see in London, pulled up and opened its door. The driver called to me menacingly, "It's time for you to come with us. It's time for you to come sing with the choir." As I began to step off the curb, my husband drove up beside him, our young kids in the backseat. "She's not going with you," he insisted. "She's coming with us." And away we sped, happy and safe.

I will receive Herceptin along with Taxol in the next phase of my treatment. My doctor says my long-term prospects are excellent. I know that I am incredibly lucky.

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collection of publications on a topic of our choice. Talking about my illness, I struggled and fought back tears, but I didn't care about the grade. I knew what this was meant to teach me.

Illness is a journey — just like grad school. I push through and learn from failure one day at a time. Walk just a little bit more today. Know it's OK that I failed to submit my homework by deadline. Don't give up on yoga because I struggle with simple poses. Every day I come to lab is a success; even if my experiment doesn't work, having the motivation to try is a triumph. I take small victories where I can get them.

My body needs me to listen to it. A professor once asked, "How are you supposed to handle the stress of grad school if you're ill?" I think I'm better equipped to handle stress than if I didn't have this illness to teach me how. I know how to manage my time and ignore negativity. I don't pull all-nighters or drink coffee or energy drinks.

Tasks are tougher now, but so am I. The pain in my elbow that kept me from taking notes that first day is nothing compared to what I push through now. I refuse to let this illness take my life from me. I know now this isn't for others to understand. I've stopped comparing myself to people. I am on my path. I have fibromyalgia, but it doesn't have me.

Each birthday since my 20th, I've worn the same Batman T-shirt I went to the hospital in. Now I'm a grad student at Johns Hopkins, and for my last birthday I took a picture outside Hopkins Hospital — not inside — demonstrating how far I've come. While I know that grad school will bring its own unique set of obstacles — a rigorous workload, project pitfalls, a loss of direction or ample criticism — I also know that I can face them. I've surprised myself with what I've been able to face so far.

Erica Avery (eavery3@jhmi.edu) is a rising second-year graduate student in the cellular and molecular physiology program at Johns Hopkins School of Medicine and a member of Steven Claypool's lab, studying mitochondrial phospholipid metabolism. Read her science blog at inmyelementscienceblog.wordpress.com.

WHEN SCIENCE MEETS SICKNESS

As a researcher, you know what happens on a molecular level when a person develops a serious illness, but what about when the ailing body is your own?

For an upcoming essay series, ASBMB Today is asking readers to send in essays about their experiences as scientists who become patients. Does your understanding make the diagnosis and treatment easier or more difficult? Does it increase your fear? Are you more critical of your doctors' decisions?

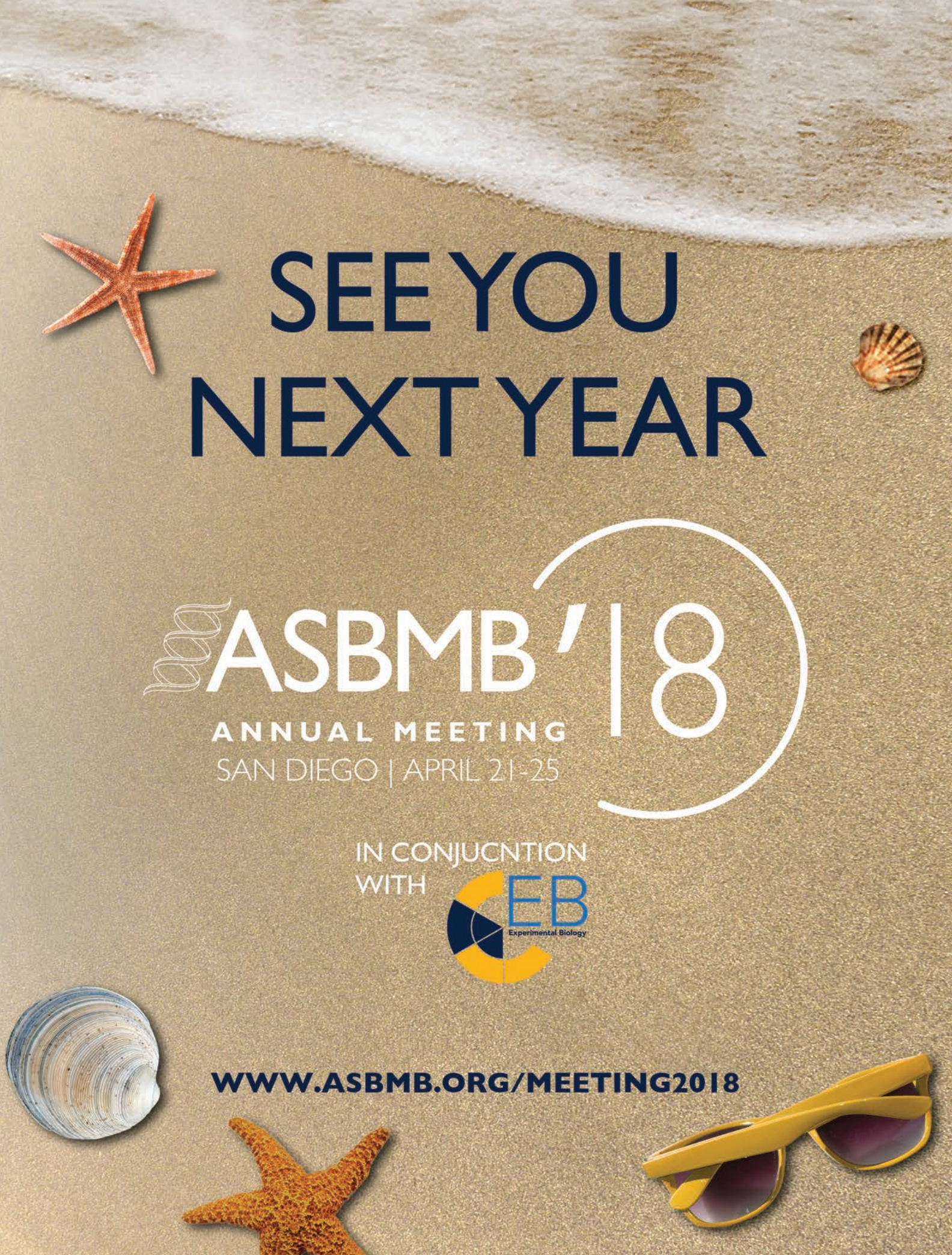
Want examples?

See the essays by Jennifer DuBois and Erica Avery on the preceding pages. These two women — one a graduate student, the other an established researcher and professor — face different diagnoses but share similar perspectives, and each is living with disease in her own way.

If you want to share your story, be honest and true. Be open to editing and coaching. Your essay must be unpublished and between 500 and 1,000 words. Submissions can be sent to asbmbtoday.submittable.com. Submit under "Science meets sickness." Please include a title and complete contact information.

Questions?

Send them to Comfort Dorn, ASBMB Today managing editor, at cdorn@asbmb.org.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