inChemistry
THE MAGAZINE FOR ACS STUDENT MEMBERS
February/March 2015

Lab Experiments
What Could Possibly Go Wrong?

ALSO IN THIS ISSUE

ACS Chemistry for Life®

ACS Chemistry for Life®

inChemistry is Going Green!

Download the inChemistry magazine app for iOS, Kindle Fire and Android devices or read it online at **www.acs.org/inChemistry**.

Download on the App Store Get it on Google play

Your digital library on chemistry careers, graduate school, and ACS student chapters.

Students – to continue receiving hard copies of inChemistry by mail, please go to **www.emailcenter.acs.org**, and subscribe.

American Chemical Society Undergraduate Programs Office
Send comments to: undergrad@acs.org.

www.acs.org

inChemistry

EDITOR: Nicole Di Fabio
MANAGING EDITOR: Lori Betsock
WEB EDITOR: Benjamin Hall
ASSOCIATE EDITOR: Blake Aronson
ASSISTANT EDITOR: Jessica Roberts
EDITORIAL ASSOCIATE: Robin Lindsey
COPY EDITORS:
Eric R. Stewart, Karen Müller
DESIGN & PRODUCTION:
Amy Phifer, Plum Creative Services
DIRECTOR, EDUCATION DIVISION, ACS:
Mary M. Kirchhoff
ASSISTANT DIRECTOR: Nancy Bakowski
EDITORIAL ADVISORS:
Corrie Kuniyoshi, Michael Mury, Jodi Wesemann

Published for student members by the American Chemical Society Education Division at 1155 Sixteenth Street, NW, Washington, DC 20036

ACS Chemistry for Life®

Canadian GST Reg. No. 127571347

inChemistry is available free to student members of the American Chemical Society and the faculty advisors to student chapters. To join ACS, go to www.acs.org.

inChemistry

THE MAGAZINE FOR ACS STUDENT MEMBERS

Volume 23 • Number 3
February/March 2015

PHOTO: SHUTTERSTOCK

Cover: How to Prepare for Laboratory Experiments. 10

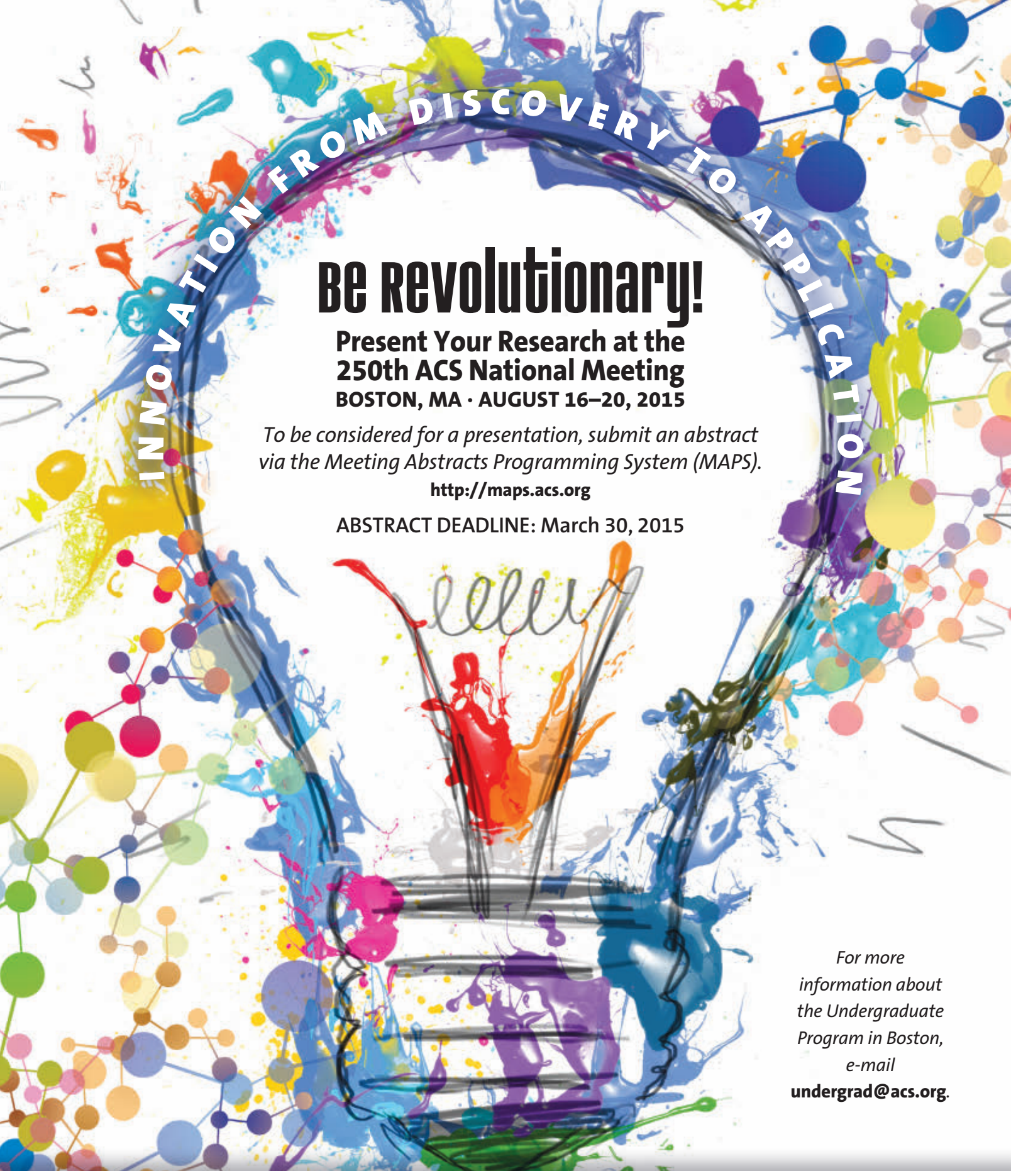
CONTENTS

ACS & YOU

FEATURES

CAREERS

CHAPTERS



Be revolutionary!

Present Your Research at the 250th ACS National Meeting

BOSTON, MA · AUGUST 16–20, 2015

To be considered for a presentation, submit an abstract via the Meeting Abstracts Programming System (MAPS).

http://maps.acs.org

ABSTRACT DEADLINE: March 30, 2015

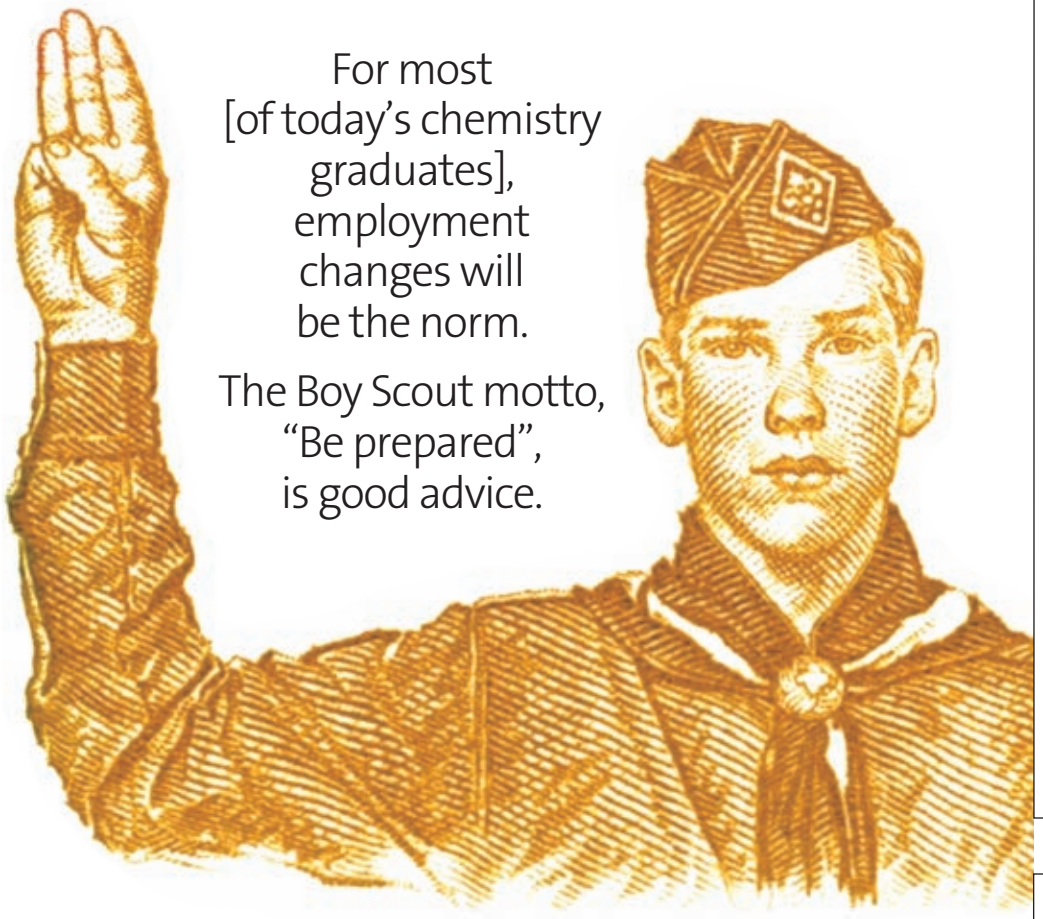
For more information about the Undergraduate Program in Boston, e-mail **undergrad@acs.org**.

ACS Chemistry for Life®

www.acs.org

EDITORIAL: **Be Prepared—Get Involved!**

BY DIANE GROB SCHMIDT



For most [of today's chemistry graduates], employment changes will be the norm.

The Boy Scout motto, "Be prepared", is good advice.

CATWALKER / SHUTTERSTOCK.COM

I will never forget the day when, as a graduate student, my chemistry professor handed me an application to become an ACS member. I still remember his words: "You need to be a member of the American Chemical Society; this is part of being a professional chemist." That advice was one of the greatest gifts I have ever received!

A lot has changed since I graduated. Today, our field is multidisciplinary. It's math and physics. It's bio and business. It's IT. It's all those things. Today's workforce is vastly different from what I first encountered. I was a long-time Procter & Gamble employee, retiring last year after spending essentially my entire career in a variety of roles with one employer. But today's chemistry graduate will likely work for several national and international employers. Some will take their skills and venture into related but very different fields. For most, employment changes will be the norm. Given all that, the Boy Scout motto, "Be prepared", is good advice.

Helping your stay prepared and take charge of your future is what ACS is all about. The ACS Career Navigator at **www.acs.org/careernavigator** and the ACS College to Career website at **www.acs.org/collegetocareer** are great examples. Whether you want to learn about career options in chemistry, take a professional course, or get help developing a résumé and finding employment, these are tremendous resources to check out.

In addition to your professional responsibilities, as a chemist you also have a responsibility to help improve the nation's understanding of science and enhance the public's quality of life. This includes a civic responsibility to share your knowledge with your elected representatives to inform policies that affect the public and your profession. ACS can help by advocating for an atmosphere that encourages growth — and there are dozens of ways that you can get involved personally. You can be an advocate for chemistry simply by explaining its importance and relevancy to family, friends, neighbors, and legislators. Our Chemistry Ambassadors program at **www.acs.org/chemistryambassadors** can help you translate science into easy-to-understand lay language, and Act4Chemistry at **www.acs.org/Act4Chemistry** can help you reach those who can lead change.

Volunteering and being an advocate doesn't have to take huge chunks of your time. You can devote as much or as little of your time and energy as you can spare. The most important thing is to do something. Ask yourself, "If not me, who? If not now, when?"

It takes more than just one person to achieve greatness. It takes collective passion and energy. It cannot be accomplished alone. Everyone has seen what happens when a person puts their hand in water and churns it up; it sends ripples and waves outward. But when they take their hand out, the water calms and soon it's like nothing ever happened. I need your help to ensure that doesn't happen. Together, we can accomplish things that will be fundamental and important to our members and our profession. I welcome your thoughts and assistance. E-mail me at **president@acs.org**.

Diane Grob Schmidt, *who recently retired from her position as section head in Research and Development at Procter & Gamble, is president of ACS.*

ATOMIC NEWS

COMPILED BY JESSICA ROBERTS

Source: ACS Office of Public Affairs Weekly PressPac, www.acs.org/content/acs/en/pressroom.html

Dolphin "breathalyzer" could help diagnose animal and ocean health

Alcohol consumption isn't the only thing a breath analysis can reveal. Researchers have been studying its possible use for diagnosing a wide range of conditions in humans — and now in the beloved bottlenose dolphin. In a report in the ACS journal *Analytical Chemistry*, one team describes a new instrument that can analyze the metabolites in breath from dolphins, which have been dying in alarming numbers along the Atlantic coast this year.

Cristina E. Davis and colleagues note that studying dolphins' health is about more than preserving their populations — the mammals can also serve as sentinels for overall ocean health. But invasive techniques such as skin biopsies and blood sampling, which are the most effective ways to test their health, are difficult to perform. An intriguing alternative comes from research on human-health monitoring with breath analyzers. Exhaled breath contains metabolites that can hint at a person's diet, activity level, environmental exposures, or disease state. Davis's team wanted to develop a way to capture dolphin breath so they could gather data on marine mammals.

The researchers designed an insulated tube customized to trap the breath exhaled from the blowhole of the bottlenose dolphin. They tested it on dolphins both in the wild and in captivity. The investigators established baseline breath profiles of healthy animals and identified changes in the breath of animals affected by disease or other factors. The researchers conclude that breath analysis could someday be used to diagnose and monitor problems in marine mammals — and by extension, in ocean health.

Read more about the research: "Metabolite Content Profiling of Bottlenose Dolphin Exhaled Breath," *Analytical Chemistry*, 2014, 86 (21), pp 10616–10624.

Discarded cigarette ashes could go to good use — removing arsenic from water

Arsenic, notoriously poisonous to multicellular life, can be extracted from drinking water using complex treatment methods. But in places that lack the equipment or technical expertise required to remove it, the element contaminates drinking water and makes people sick. To solve this problem, researchers have developed a new, low-cost, simple way to remove arsenic using leftovers from another known health threat — cigarettes. They report their method in ACS's journal *Industrial & Engineering Chemistry Research*.

Jiaxing Li and colleagues explain that naturally occurring and industry-related arsenic contaminates groundwater at high levels in many countries, including Chile, China, Hungary, and Mexico. The odorless, tasteless element can cause skin discoloration, stomach pain, partial paralysis, and a range of other serious health problems. While the technology for removing arsenic from water exists and is in widespread use in industrialized areas, it is expensive and impractical for rural and developing regions. Researchers have been exploring the use of natural waste materials such as banana peels and rice hulls for removing arsenic from water, but so far these have shown limited efficiency. Recognizing that the porous structure of cigarette ash could be better suited to this purpose, Li's team decided to test it.

In a simple, inexpensive, one-step method, the researchers prepared cigarette ash with a coating of aluminum oxide. When they tested the material with contaminated groundwater, they found it removed more than 96% of the arsenic, reducing its levels to below the standard set by the World Health Organization. Because cigarette ashes are discarded in countries around the world and can easily be collected in places where public smoking is allowed, it could be an economical solution for a serious public health issue.

Read more about the research: "Synthesis of Alumina-Modified Cigarette Soot Carbon As an Adsorbent for Efficient Arsenate Removal," *Industrial & Engineering Chemistry Research*, 2014, 53 (41), pp 16051–16060.

ALL PHOTOS IN ATOMIC NEWS: SHUTTERSTOCK

Why plants don't get sunburn

Plants rely on sunlight for photosynthesis, but they also need protection from harmful UVB radiation, just as humans do. Recently, researchers discovered a group of molecules in plants that shield them from UVB radiation. Now, in an article in the *Journal of the American Chemical Society*, one team reports on the mechanics of how these natural plant sunscreens work.

Timothy Zwier and colleagues at Purdue University note that the UVB radiation to which plants are exposed daily can cause mutations to a plant's DNA and hinder its growth. Biochemical tests have shown that plants produce sinapate esters and send them to the outer layer of their leaves to protect themselves. These molecules appear to block UVB radiation from penetrating deeper into leaves where it might otherwise cause DNA mutations. Although researchers have been amassing evidence that points to sinapate esters as the protective molecules, no one had investigated in detail what happens to them under UV exposure in an isolated environment. Zwier's team wanted to understand this process, which they explored by testing a series of sinapic acid derivatives.

The researchers transformed the sinapate esters into the gas phase and exposed them to UVB radiation from a laser. They found that sinapoyl malates, which plants use as a screen against UVB, were inherently capable of soaking up radiation at every wavelength across the UVB spectrum. Thus, they are remarkably efficient at absorbing harsh radiation that could otherwise damage the plant. These findings further strengthen the idea that sinapate esters function as plant-made sunblock.

Read more about the research: "Plant Sunscreens in the UV-B: Ultraviolet Spectroscopy of Jet-Cooled Sinapoyl Malate, Sinapic Acid, and Sinapate Ester Derivatives," *Journal of the American Chemical Society*, 2014, 136 (42), pp 14780–14795.

$2x10^{19}$ The comparative strength of the world's strongest superacid, fluoroantimonic acid, to 100% sulfuric acid.

80 The length of wire in kilometers that can be formed from stretching an ounce of gold.

24 The atomic number of chromium, the elemental impurity that is responsible for the red color of rubies and the green of emeralds.

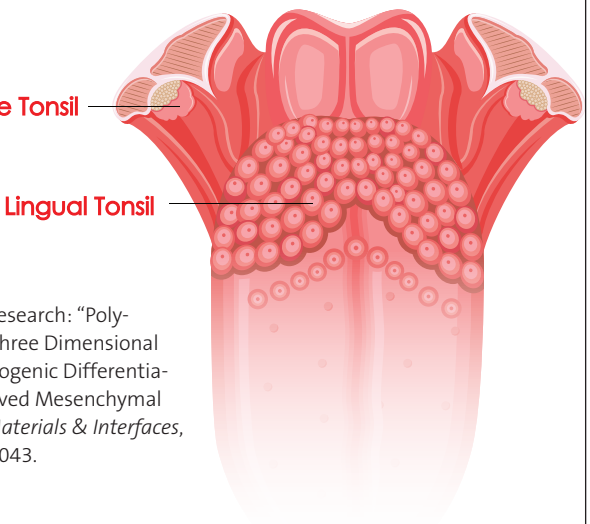
9000 The number of "lead" pencils one could fill from the amount of carbon in the human body.

Tonsil stem cells could someday help repair liver damage without surgery

The liver performs critical functions, such as ridding the body of toxins. Its failure can be deadly, and there are few options for repairing it. But in the journal *ACS Applied Materials & Interfaces*, researchers now report on a way to potentially inject stem cells from tonsils, a body part we don't need, to repair damaged livers — all without surgery.

Byeongmoon Jeong and colleagues point out that currently, the only established method for treating liver failure or severe cases of liver disease is complete or partial transplantation. But the need is much greater than the number of available organs. Plus, surgery has inherent risks and a hefty price tag. A promising alternative in development is transplanting liver cells. One such approach involves using adult stem cells to make liver cells. Stem cells from bone marrow could be used, but they have limitations. Recently, scientists identified another source of adult stem cells that could be used for this purpose — tonsils. Every year, thousands of surgeries are performed to remove tonsils, and the tissue is discarded. Now it could have a new purpose, but researchers needed a way to grow them on a 3D scaffold that mimics real liver tissue. Jeong's team set out to do just that.

The researchers encapsulated tonsil-derived stem cells in a polypeptide thermogel that turns into a gel at body temperature. They added growth factors to encourage the stem cells to become liver cells. Then, they heated the combination up to a normal body temperature. The result was a 3D, biodegradable gel that contained functioning liver cells. The researchers conclude that the same process has promise — with some further tweaking for ideal conditions — as an injectable tissue engineering technique to treat liver disease without surgery.



Read more about the research: "Polypeptide Thermogels as a Three Dimensional Culture Scaffold for Hepatogenic Differentiation of Human Tonsil-Derived Mesenchymal Stem Cells," *ACS Applied Materials & Interfaces*, 2014, 6 (19), pp 17034–17043.

CHEMISTRY OF NATURAL RESOURCES

249th ACS National Meeting
DENVER, COLORADO • MARCH 22–26, 2015

UNDERGRADUATE PROGRAM

SUNDAY, MARCH 22

Undergraduate Hospitality Center
8:30 AM–5:00 PM

Undergraduate Research Oral Session
8:30 AM–5:00 PM

Making the Most of Your First National Meeting
9:00–9:45 AM

Graduate School Reality Check: Getting In
Cosponsored by the ACS Younger Chemists Committee
10:00–11:15 AM

Chem Demo Exchange
11:00 AM–12:30 PM

Graduate School Reality Check: You're In– Now What?
Cosponsored by the ACS Younger Chemists Committee
11:15 AM–12:30 PM

Networking Social with Graduate School and Research Opportunity Representatives
1:00–5:00 PM

How to Be a Successful ACS Student Chapter
1:00–2:30 PM

***Symposium:* Can You Have a Life and Career?**
Cosponsored by the ACS Women Chemists Committee
2:45–4:00 PM

***Workshop:* Improving Scientific Communication Skills**
4:00–5:30 PM

***Workshop:* Careers in Teaching Chemistry**
4:00–5:30 PM

Student Chapter Awards Ceremony
7:00–8:30 PM

Undergraduate Social
8:30–11:00 PM

ACS Chemistry for Life®

Attention: Graduate School Recruiters!

Network with highly qualified undergraduate students who are interested in learning more about your graduate school programs. Register to participate in the graduate school recruiting events. To register, go to www.acs.org/GradSchoolRecruiters. For more information contact Lori Betsock at l_betsock@acs.org.

All events are sponsored or cosponsored by the Society Committee on Education Undergraduate Programs Advisory Board.

CHAIR: Matthew J. Mio • *University of Detroit Mercy, MI*

PROGRAM CHAIR: Daniel J. Swartling • *Tennessee Tech University, Cookeville*

MONDAY, MARCH 23

Undergraduate Hospitality Center
8:30 AM–5:00 PM

Undergraduate Research Oral Session
8:30 AM–5:00 PM

Symposium: Biomass to Fuel & Products
Cosponsored by the ACS Cellulose and Renewable Materials Division and the ACS Division of Energy & Fuels

9:00–10:30 AM

Workshop: Networking 101
9:45–10:45 AM

Workshop: Chemists Celebrate Earth Day
Cosponsored by the ACS Committee on Community Activities

9:45–11:45 AM

Symposium: Forensic Toxicology of Marijuana
Cosponsored by the ACS Divisions of Chemical Toxicology and Business Development & Management

10:45–11:45 AM

Undergraduate Research Poster Session
Cosponsored by the ACS Divisions of Agricultural and Food Chemistry, Analytical, Environmental, Inorganic, Medicinal, Physical, and Polymer Chemistry, Biological Chemistry, and Geochemistry

12:00 NOON–2:00 PM

Eminent Scientist Lecture *"Sustainability in the 21st Century: Optimizing Complex Interdependent Systems", with Henry Kohlbrand, Dow Chemical Company*
Cosponsored by the ACS Cellulose and Renewable Materials Division and the ACS Division of Energy & Fuels

2:30–3:30 PM

Speed Networking with Chemistry Professionals
Cosponsored by ACS Corporation Associates and the ACS Senior Chemists Committee

3:45–5:15 PM

Kavli Lecture
4:00–6:30 PM

Sci-Mix/Successful Student Chapter Posters
8:00–10:00 PM

TUESDAY, MARCH 24

Chemistry and the Environment Film Series
Cosponsored by the ACS Committee on Environmental Improvement

12:00 NOON–2:00 PM

Program format and times are subject to change. Please consult the final program.

Get Ready to Be Amazed!

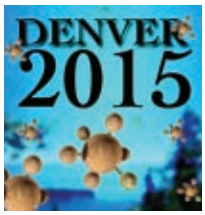
Making the Most of the 249th ACS National Meeting in Denver, CO

BY ACS STAFF

In just a few short weeks, on March 22–26, 2015, you could attend the 249th ACS National Meeting in Denver, CO. Perhaps your advisor has been encouraging you to go or you've heard from your friends about how incredible it feels to be surrounded by thousands of people who share your interests.

The national meeting is expected to attract 14,000 chemists, chemical engineers, academicians, graduate and undergraduate students, and other related professionals. More than 8,000 papers will be presented along with nearly 100 poster sessions. There is also the must-see Exposition, great social events, a Career Fair, and Career Pathways courses... as well as hundreds of workshops and many networking events, tons of people to meet, cool sightseeing opportunities, and excellent food to enjoy. The opportunities are mind-boggling!

Listed below are some tips on making the most of your time in Denver — and choosing events that will be enjoyable, educational, and rewarding.



Download the app

Although printed programs are provided at each national meeting, a better solution is to go to the App Store and download the free ACS Mobile Meeting app. The app is much easier to use than a printed program, and you'll always have it with you for reference.

With the app you can search for interesting papers, posters, and events. You can search for oral and poster presentations by division, day, author, meeting theme, or topic — and also check out governance and social events, Sci-Mix posters, and more. In addition, there is a wealth of information about the city of Denver, the ACS shuttle service, a map showing the convention center and participating hotels, and much more. Best of all, the app enables you to create your own personalized schedule.

Check out the the Undergraduate Program

The Undergraduate Program runs from Sunday to Tuesday, March 22–24. It includes a wide range of events developed specifically for undergraduate students, including symposia, workshops, undergraduate research oral and poster sessions, and opportunities to network with chemists, graduate school recruiters, and summer research opportunity representatives — not to mention undergraduates from across the United States. You'll hear interesting speakers and learn some fascinating chemistry, and even attend events that will help you strengthen your chapter. For more details, including a complete list of events, dates, and times, see pages 6–7.

Network with your peers

Attending the national meeting lets you network with other students who have similar interests and meet fascinating chemistry professionals. The opportunity could be life-changing — especially if you do a little preparation.

First, print some business cards. They don't need to be fancy. Include your name, the name of your institution, and your e-mail address. You can order 500 cards for less than $10.00 online, print them yourself, or go make use of a local instant printer. Whenever you meet someone at the meeting, offer them your card and ask for theirs. Make a note on the person's business card to help you remember them and your conversation, and follow up later with an e-mail.

The Undergraduate Program offers a Networking 101 course to help you learn the basics of networking. Then go to the Undergraduate Speed Networking with Chemistry Professionals event to meet chemists from different fields. The Undergraduate Research Poster Session and the Undergraduate Social provide great opportunities to meet students from other schools. The Networking Social with Graduate School and Summer Research Opportunity Representatives is another great opportunity to make yourself visible.

It also helps to decide in advance which areas of chemistry most interest you. Then, plan to learn more by visiting related posters, talking to presenters at the Undergraduate Research Poster Session, and meeting with graduate school recruiters to learn about graduate programs that relate to your interests.

Visit the Exposition

Be sure to visit the ACS Exposition, which will be open throughout the meeting. More than 300 exhibitors will showcase services, instruments, books, computer hardware, scientific software, and an array of lab equipment. You can also attend a number of free exhibitor workshops to

In the ChemDemo Exchange Undergraduate Program event, chapters share tips on how to incorporate household materials into hands-on demonstrations.

Students from the Northern Kentucky University student chapter pose with their chapter poster at Sci-Mix in Dallas, TX. In Denver, more than 100 chapters will present their posters at Sci-Mix.

learn about state-of-the-art technologies. Plus there are fun giveaways, such as candy, pens, hats, and more!

Inside the Exposition you will find the ACS Career Fair Recruiters Row, where employers showcase their products and services. Also, be sure to visit the ACS booth, where ACS staff members will present the many benefits, services, products, and merchandise offered by ACS.

Branch out

It is fun to attend events with your friends from your student chapter — but try to get away from the group for a while to visit some posters on topics that interest you. Browse with your national meeting app and note the numbers, times, and locations of the posters that pique your curiosity, and visit them when it's convenient.

Mention to the presenter that you are an undergraduate student and you're interested in their topic. After you learn about the presenter's research, try to find out more about them. Ask open-ended questions, such as "How did you get interested in the topic?","How did you find your first job?", and "Does your employer offer internships?". If you're thinking about applying to graduate school, you might also ask questions about the presenter's graduate school experience. Be sure to trade business cards with each presenter and to follow up later.

Go to Sci-Mix

Sci-Mix, held at 8:00–10:00 pm on Monday, March 23, is a meeting-wide social and poster presentation event, with the posters representing the best of each ACS division. Review the Sci-Mix program in advance and note which posters you'd like to view. Be sure to sign up for the giant chocolate bar raffle!

Hear the Kavli lectures

The Kavli lecture series promotes groundbreaking discovery and public understanding of how chemistry can help solve some of the world's mounting challenges. On Monday, March 23, Theodore Betley, Professor of Chemistry and Chemical Biology at Harvard University, will speak on "Radical Frontiers in Catalysis", from 4:00–5:00 pm in the Colorado Convention Center Bellco Theatre, followed by Laura L. Kiessling, Steenbock Professor of Chemistry and Laurens Anderson Professor of Biochemistry at the University of Wisconsin-Madison, who will speak on "Us Versus Them: Distinguishing Humans from Microbes with Carbohydrates", from 5:30-6:30 pm.

Explore career options

If you have the time, take an ACS Career Pathways course to discover your ideal career path. In the first course, "Finding Your Pathway", you'll learn about the four main career pathways available to chemical professionals: higher education, industry, government, and entrepreneurial careers — and why each one may or may not be the right choice for you.

In addition, you'll also learn about the job market and hiring trends. The workshop helps you inventory your own values, interests, strengths, and weaknesses so that you can select the career pathway that's best for you and later take a course focusing on it.

"Acing the Interview" addresses the fundamentals of successful interviewing and explains how to interview for different types of hiring organizations. You'll also participate in two or three quick mock interviews. With the facilitator's feedback, you'll quickly incorporate what you've learned to ace your next interview and begin your career.

Consult the Undergraduate Program Guide

A few weeks prior to the meeting, all undergraduates who have pre-registered for the meeting will receive a copy of the Undergraduate Program Guide by e-mail. In addition to detailed information about the Undergraduate Program and other events of interest, it also provides tips on finding food at the national meeting and nearby restaurants, as well as getting around the city.

The take-home message

Attending an ACS national meeting will leave you with a deeper understanding and appreciation of your chosen field of study and of ACS itself. You may even be a step closer to choosing a graduate school or area of focus... or you may even find a new career direction.

If you are unable to attend the meeting in Denver, don't despair. Challenge yourself to plan ahead and attend the 250th ACS National Meeting & Exposition on August 16–20, 2015, in Boston, or the 251st ACS National Meeting & Exposition on March 13–17, 2016, in San Diego.

See you soon at an upcoming ACS national meeting! iC

How to Prepare for Laboratory Experiments

.... and What to Do When They Go Wrong

BY DARYL RAMAI

Congratulations — you've been accepted into a research lab to study the structure of an enzyme involved in cell signaling. How exciting!

The start of a new research project is often a very thrilling experience; the anticipation of a potential discovery piques our imagination. But as you begin planning out your project, have you thought about what equipment is required? What reactions must be performed, and how many times? Or what could possibly go wrong?

As a student of science, you will recall from your prior chemistry lab courses that sometimes experiments don't work, or the results you expected don't materialize the first time. Or the second. Or the tenth. Does this mean that you're not cut out for science? Of course not! Research takes place through trial and error, and usually with more error than trial. Just remember: even poor data can be useful, and could potentially help you to understand your work. Let us explore a few ways in which you can adequately prepare before performing an experiment — whether you are following a handout in a course, reproducing an experiment based on a publication, or running your own research experiments.

Designing an experiment

When designing any experiment, the first step is to perform background research. Find out who has already conducted similar experiments, and learn from their experience. Are there any safety or procedural precautions? Do any of the reagents have violent reactions to water, light, or friction? Does the experiment work better in methanol solution or ethanol? How dry do your reagents need to be? Even if you are following a lab manual, you will benefit from the details provided. Learn as much as you can before you even consider designing your experiment.

Next, it is important to invest adequate time to do calculations, gather reagents and equipment, and think about what kind of data you're expecting. Think through the experiment before you start, and have plenty of back-up plans in case something goes wrong. Planning alternative experiments beforehand can help you use your lab time effectively if something goes wrong with your first experiment. Also remember that most labs have a set budget for research, and developing a properly written experimental procedure can save time and can also prevent labile and expensive chemical materials from spoiling.

If you are following a published protocol, you may run into a situation where your lab does not have a specific reagent. So what do you do? If you cannot purchase the reagent, you may be able to substitute an alternative. Sometimes finding an alternative can be easy. For example, what if the lab ran out of the bicarbonate needed to prepare a buffer? Maybe you could replace bicarbonate with another buffer with a similar pK_a. Also, it is possible to find an alternative pathway and reagents through using SciFinder or SciPlanner, two ACS resources designed for this purpose.

Laboratory instruments

Using only a manual to learn how to use a complex instrument, such as a mass spectrometer or UV spectrophotometer,

Case in Point: Contaminant Tampering

Daniel Robie recalls an experience where contaminants from the instrument tampered with his experimental sample: "In the late 1980s, I was putting together an apparatus to detect nitric oxide by the then-new technique of resonantly enhanced multiphoton spectroscopy. To see whether the apparatus worked correctly, I ran some argon through a microwave discharge in a Pyrex tube and then into the observation cell. At low pressures, a distinctive and unexpected spectrum showed up. It didn't match what was known about argon spectra. Was it a new set of argon states? This would have been a big deal, since argon is supposed to be pretty well understood.

I worked out the ionization energy (IE) the spectral carrier would have, and then gave a talk about it in my research group. When I mentioned the value I had for the IE, one of the audience members jumped up and ran out of the room. When he returned five minutes later, he announced that he had recognized the IE, and confirmed that it was that of sodium! Other features of the spectrum were consistent with this identification. Apparently, at low pressures the plasma energy was sufficient to blast sodium out of the Pyrex walls and into the gas phase. We changed to a ceramic tube that could withstand the higher energies." iC

SHUTTERSTOCK

might seem like a daunting task. Additionally, your lab might have specific protocols or use special accessories that are not in the manual. In any case, if it's your first time using a particular piece of equipment, ask to spend some time with experienced colleagues or supervisors to learn how to use it properly.

Begin by running several standards tests or controls that can easily be referenced. Not only will this help you become familiar with the instrument, it will also calibrate the instrument for your experiment. For instance, if it's your first time using a mass spectrometer, start by learning how to collect the mass of a known compound and compare it to its standard reference value. While this does require a significant investment of time, it is important to remember that during this process, you are acquiring skills that will be useful with future experiments and will make you a more well-rounded scientist.

As you become comfortable with the instrument, begin running your own experimental samples. In order to allocate the right amount of time for an experiment, roughly estimate how long it takes to do the experiment, multiply by the number of trials, and then set aside that amount of time. Something will almost certainly go wrong the first time through. As you proceed, go over in your mind the way things are supposed to work, look at the settings to make sure they are correct, and check the instrument signals such as oil levels, vacuum, pumps, and so forth. Most importantly, ensure that you are actually recording the data. Many times students will run their samples through but forget to click "record" or update their lab notebooks. Document the settings and readings you obtain, no matter how trivial they might seem. Small variations can mean the difference between success and failure in an experiment. Stay focused on your experiment. This is not the time to multitask by checking e-mail, Facebook, or anything else until you are absolutely sure everything is routine.

As data are being collected, you should decide whether the results are those you anticipated. Is your hypothesis reasonable? Is the data signal what you expected? If not, is the experiment running correctly? If you decide that the instrument is at fault, check the standards — a series of blank samples that are identical to yours but missing the reagent you are analyzing. In addition, Daniel Robie, assistant professor of chemistry at York College, CUNY, recommends going over a simple checklist. Robie has dealt with instrumental problems while designing laser-based research experiments to study chemical reactions. He recommends checking the following:

- **Check for faulty power switches, blown fuses or circuit breakers, weak batteries, and unplugged cables.**
- **Are the values for instrument parameters correct?**
- **Are reagents fresh? At the right grade of purity?**
- **Have your compounds hydrolyzed? Water in the air or workspace can interfere with the results.**
- **Consider possible temperature or vacuum effects.**
- **Finally ask for assistance.**
- **Reboot computers, and restart the instrument if possible.**


THINKSTOCK

Failed experiments

While the road to discovery starts out as thrilling, many students, and even experienced researchers, get discouraged when experiments fail. Maybe there's a quick fix, or perhaps the hypothesis is simply wrong. The only way of telling is through trial. Emmanuel Chang, associate professor of chemistry at York College, says, "Experiments don't always go the way we expect. This can be frustrating, but it's an important lesson. Undergraduates usually have limited time, and their understanding of the scientific process is still emerging. The difficulty as a mentor can be to rein in the enthusiasm, and to provide a longer view of how discovery actually occurs over months and years."

Science does not care what we think, and will often humble us. Chang recalls starting a research project that he thought would take him two months to perform and gather the necessary results; in reality, the project took over a year to complete. Chang adds, "Sometimes, the problem can be traced back to simple errors — a mistaken calculation, a misoriented gel, or a pipetting error. Other times, it's a matter of trying and trying again: increase the concentration of the reagent, incubate longer, or change the pH. When these fail, then it's time to rethink the hypothesis. Maybe the idea was straight-up wrong, or at least needs modifying."

From learning how to properly pipette so as to minimize error, to developing an eye for what may be "good or bad" data, figuring out how to properly conduct an experiment takes time, and a whole lot of practice. Chang says, "Sometimes it may not be in the cards for the solution to be found within the limited time that an undergraduate has in a lab. In such cases, the task is to realize that despite our so-called failure, we actually learned something. Or, as Thomas Edison once said, "Results? Why, man, I have gotten lots of results! If I find 10,000 ways something won't work, I haven't failed. I am not discouraged, because every wrong attempt discarded is often a step forward." iC

Daryl Ramai *is a science writer who lives in New York.*

To repeat or not to repeat?

How many samples are enough? How many times should I repeat the experiment? Let us first distinguish between these two concepts in order to understand their value in designing an experiment. First, sample size refers to the number of items measured from a single experiment. Thus, if a reaction was done in a single beaker, after which 10 mL aliquots were pipetted into three individual cuvettes for UV testing, we would say that three measurements were made or that the experiment had a sample size of three. If the experiment was performed the next day from the very beginning, we would now say that the experiment was repeated twice. As it turns out, increasing sample size is one of the most common ways to decrease experimental noise — that is, random experimental errors. So, exactly how large should your sample size be?

The precise answer takes into account statistical analysis, but as a rule of thumb, the smaller the expected effect, the greater should be your sample size. In other words, if you expect to use UV analysis to observe a shift in wavelength of only 20 nm, then you should consider a relatively larger sample size, as opposed to an expected shift of 200 nm. Experimental repetition is similar; however, there is a point at which repetition becomes unproductive and produces diminishing returns.

According to "Winning the Accuracy Game", an article written by Hugh G. Gauch, Jr., for *Scientific American*, repeating an experiment a few times results in a large increase in the statistical chance that the average of the repeats is more accurate than a single trial. Great — but does that mean that you should repeat the experiment as many times as possible? Technically, the answer is yes, but realistically, doing so would be expensive and unnecessary. The fact is, subsequent repeats provide little return on investment.

In general, you should be able to repeat your experiment a minimum of three times. Why three? Imagine that you are graphing your data. If you have one data point, you don't have a trend. If you have two data points, you can make a straight line, but you cannot ascertain if you have a trend yet. However, if three data points fall into a line, you can start to feel confident that you have a trend. iC

ACS
Chemistry for Life®

www.acs.org/scholars

American Chemical Society Scholars Program

Pathways to Success in the Chemical Sciences

Inviting African-American, Hispanic, & Native American students to apply for renewable scholarships for the 2015–2016 academic year.

Up to $5,000 will be awarded to under-represented minority students who want to enter the field of chemistry or chemistry-related fields, such as environmental science, toxicology, and chemical technology. High school seniors and college freshmen, sophomores, or juniors are eligible to apply.

Eligible applicants include those who are interested in:

- **pursuing four-year degrees in the chemical sciences**
- **transferring from two-year colleges to four-year colleges to pursue chemical science degrees**
- **pursuing two-year degrees in chemical technology.**

For more information, and to access the online application form, visit:

www.acs.org/scholars

Application deadline is March 1, 2015.

Approximately 100 scholarships will be awarded.

Finding Your Career Path

Four Tips for the Indecisive

BY JONATHAN MEYERS

Turn right. Take your first left. Turn left again at mile marker 318.

Traveling to your destination is easy when you have a GPS device, a map, or well-written instructions to guide you. But it's not so easy to do when you haven't yet decided where you want to go. It took me a long time to figure out what I wanted to do with my education in chemistry. If you've felt a similar uncertainty, I hope the following tips will help you make that momentous "what-do-I-do-with-my-future" decision and set the best course for your destination.

I graduated in April 2014 from Brigham Young University-Idaho (BYU-Idaho), with a B.S. in chemistry. Although I was a chemistry major from the beginning, I struggled to discover my particular niche. I loved organic, analytical, and even physical chemistry. In fact, I loved every chemistry course I took. How was I supposed to choose one area of focus?

If you're in a similar position, I recommend trying the following four things that helped me make my decision and still help me as I navigate my career choices. I advise trying them all simultaneously and consistently.

One Think about the big picture

Identifying and keeping in mind the purpose for your life is one of the most important things you can do. After you have finished reading this article, sit somewhere quiet and ponder some "big-picture" questions. What makes you happy, and what do you want from life? What captivates you ... and what do you want to experience or learn?

It may be a bold claim, but I doubt the reason you exist is to measure the concentrations of a trace chemical in a remote environment (if that assertion makes you upset, please keep reading). Your purpose might be to cure a disease, solve a problem in a remote part of the world, or provide others with important scientific tools. Or maybe it is to teach children. I have been very interested in energy, but the purpose of my life is not to study solar cells. I more fully discovered the purpose for my life when I got married. My life decisions now take into consideration my spouse and future family.

But wait... how did this realization help me narrow down my career options and make a decision? For me, it relieved a lot of stress knowing that one small career decision wasn't going to throw everything off. As long as I am fulfilling my purpose, life is going well. Try it for yourself, and you will discover why finding your purpose is so important.

Two Be aware of recent science and scientists

I was returning to the United States through the Los Angeles airport when a U.S. Customs officer asked me why I had been out of the country. After explaining to him that I was completing an internship in chemistry, he told me about an emerging area of promising research that I had not heard of before.

The point is that you can learn new things about science in many places and from unexpected sources (such as the Customs officer). Keep note of your findings and rank each according to your interest level. When you have time, investigate those ideas further. Find out who is leading the research at the top of your list and where they work. If you Google the researchers or look them up on LinkedIn and begin communicating with them early on in your education, you may feel more comfortable talking with them when you are applying for work or graduate school, and they will already know you and your level of understanding.

Here are a few of the places I look for interesting tidbits about science:

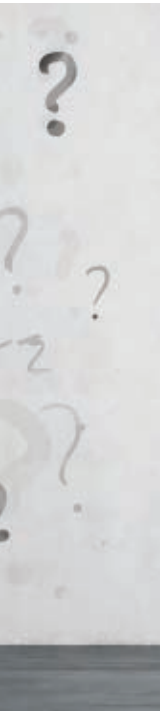
- ***Chemical & Engineering News*. Great summaries of modern research and practical applications.**

- **Science Elements podcasts. As much as I love music, I prefer to listen to these short weekly podcasts that summarize new articles published in all ACS journals. This is a quick and easy way of discovering amazing science. ACS also provides links to the original articles for when you want to learn more. You can subscribe to Science Elements on iTunes or access the broadcasts on the ACS website at www.acs.org/pressroom.**
- **Local/regional/national/international chemistry conferences. I wish I had attended more of these as I was starting out. I don't know of a better way to hear about science and meet scientists. If you are willing to talk to scientists, they can guide you through more than just their research. Some of my large decisions were made immediately following a conversation with a researcher. Go to www.acs.org/meetings and click on ACS Meeting Locator.**
- **Internship postings. You might be surprised at the projects that are available for undergraduate students. Whether it is sponsored by a university, the National Science Foundation, or another group, an internship is a great way to explore new research topics and become personally acquainted with the researchers. Explore these opportunities at www.acs.org/GetExperience.**

Please note that these are some resources that I find most rewarding — but there are many, many other resources that also provide useful information.

Three Perform supervised research

The courses I took as an undergraduate were excellent, as were the professors who taught me. Neither the courses nor the labs, however, were able to convince me that I would love working in a specific area. This understanding came only as I began doing guided research with my professors outside of my normal coursework.



There are research opportunities just waiting for you to uncover. Some of you may have research built into your degree curriculum. If you attend a school like BYU-Idaho, where research is not a central focus, you may have to knock on a couple of doors and perhaps even write your own research or grant proposal. In my experience, professors are more than willing to have you do the research to test their constantly forming ideas. My research started because I was studying in a small room while two friends discussed their research about a "superbug". I asked what they were talking about, and was instantly pulled into their biochemical research. I ended up focusing on a side project determining the rate of oxidative degradation of beta-carotene (food for the superbug), and later ended up doing completely different research designing prototypes and actuators for soft, silicon-based robots. Each research experience taught me what research topics I liked and disliked.

Once you complete your research project, it is very important to present at scientific conferences. The knowledge I gained from performing supervised research fluctuated over time, but it always peaked during the last two weeks before the conference. Presenting my own research forced me to read more, experiment more, and make more connections than researching without presenting. I presented at six conferences, and I wish I had presented at more.

Four Understand the boundaries

While many things in life have clearly defined boundaries, your studies should not be one of them. Don't be afraid of incorporating into your career a thread of biology, physics, engineering, or even the arts!

I was awarded a 2013 German Academic Exchange Service (DAAD) scholarship for an internship in Leipzig, Germany. My wife Kalie and I moved to Germany three days after we were married. Our three months in Germany taught me that if you want to research in a particular place or on a specific topic, you can do it!

In August 2013, at the 3rd Transatlantic Frontiers of Chemistry Symposium, held at Kloster Seeon near Munich, we listened to a lecture from Helmut Schwarz, the president of the Alexander von Humboldt Foundation. His theme was "Overcoming Frontiers in Science". Paraphrasing his address, nature doesn't single out particular divisions of science. A leaf doesn't decide, "Your job is done, Chemistry; it is Biology's turn now." Science itself ignores boundaries and frontiers, and so should we.

As you ponder your interests, do not feel limited by the boundaries of science. Search out the answers to your questions, and learn all you can as you cross back and forth over those imaginary boundaries. Some occasional critics have "written off" my soft robot research as being more engineering than chemistry. They couldn't see my vision for the robots' chemical future, and they ignored the tools I used and skills I learned that I will use in my chemical future. Boundaries in science only slow our progress.

Time to get started

Your future awaits! I am very optimistic that you will find your own direction for your future work, especially if you keep in mind your life's purpose, stay aware of current research and know leading scientists, get hands-on experience through supervised research, and dissolve imaginary boundaries in science. iC

Jonathan Meyers *is a recent chemistry graduate from Brigham Young University-Idaho and soon-to-be graduate school applicant; he is happy to have a clear vision for his future.*

Earning a Chemistry Ph.D.

Is It Worth the Effort?

BY NANCY McGUIRE

Is it worth the effort to go after a Ph.D. in chemistry?

The answer to this question depends on what you're trying to accomplish. Nancy Goroff, associate provost for research, education, and professional development at Stony Brook University, puts it this way: "I believe that a Ph.D. in chemistry gives students valuable life skills… but it's not for everyone." She adds, "You have to care about scientific discovery. You have to be the kind of person who gets excited about success when it comes."

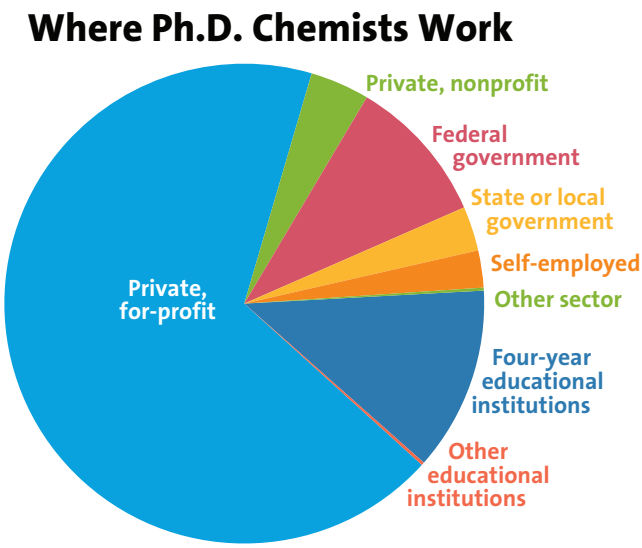
Going in with your eyes open

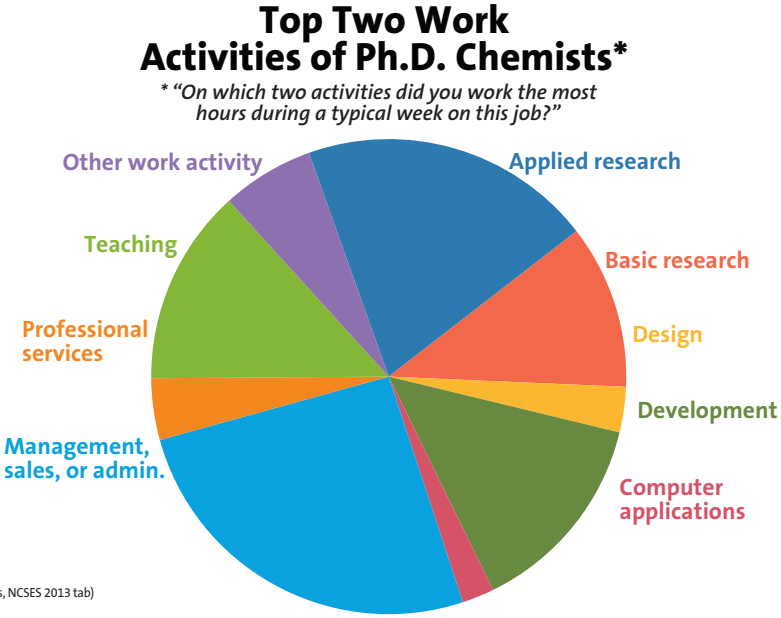
First and foremost, the chemistry Ph.D. is a research degree. If you dream of doing research and making new discoveries, and if the idea of being a leading expert in a specific field excites you, then you are more likely to benefit from a doctoral program. If you like coming up with your own ideas, enjoy taking the lead on big projects, and aspire to be a mentor to up-and-coming young scientists, getting a Ph.D. is likely to be worth the effort. If you are happier managing a lab for a lead researcher or running a service analytical lab, then a master's degree is probably a better bet. A master's degree can also be good preparation for a career in management or program administration, government policy, patent law, communications, or other non-laboratory areas. And of course you can go back for your doctorate later on, if you decide that's for you.

Does the job sector you're going into require a Ph.D.? A little research will help you determine if a Ph.D. is an absolute requirement, an option that will give you a specific advantage, or something that's not really necessary (see charts). Some sectors of chemistry have a strong preference for Ph.D. holders. Go to the ACS College to Career website at **www.acs.org/collegetocareer** for more information. Your own internal motivation and values are key factors in your decision, but several external factors can increase the odds that the time you spend earning a Ph.D. will pay off over the long term.

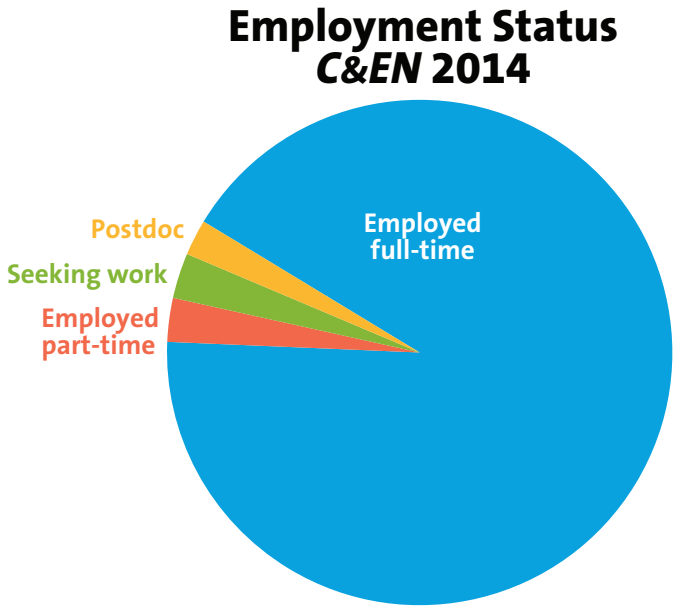
Choosing the right school

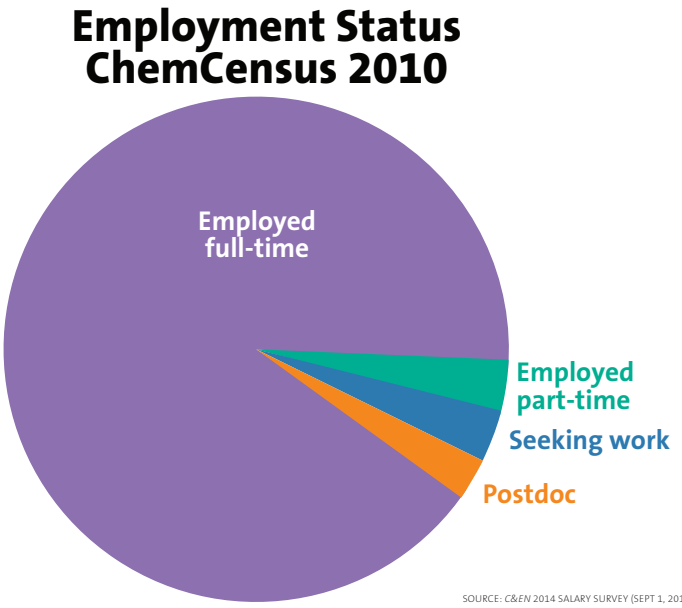
If you're planning on an academic career, it's important to choose a graduate school that will help you stand out from the crowd. The larger and more traditional universities often focus on training graduate students to perform basic research in an academic environment — in essence, they are training the next generation of college professors and academic researchers. Hav-



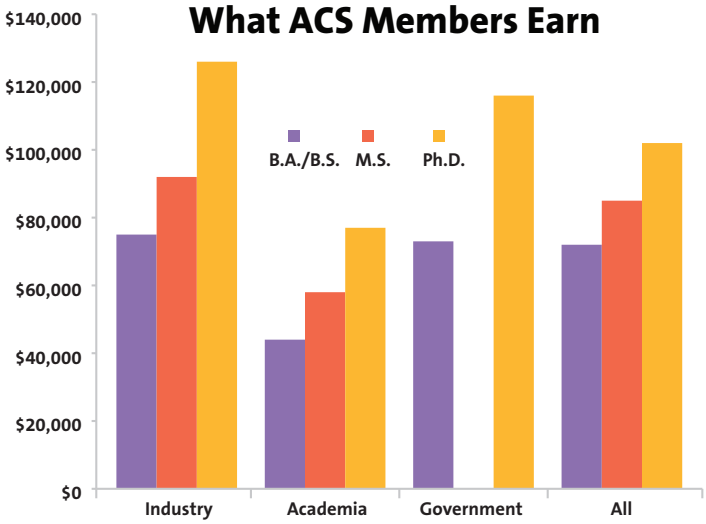


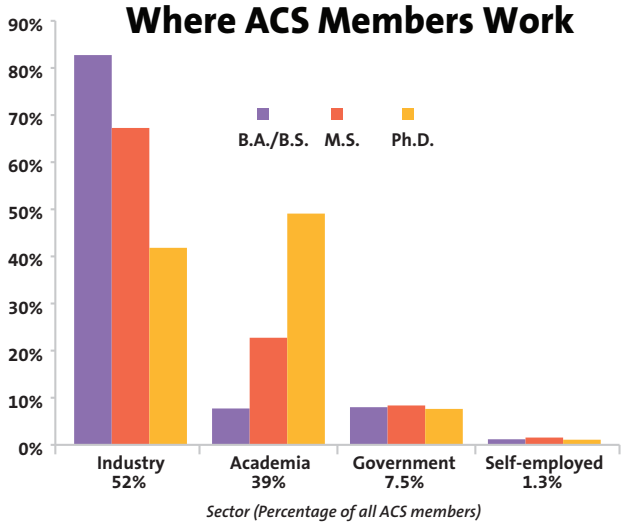
Source: National Center for Science and Engineering Statistics, Survey of Doctorate Recipients 2013, http://ncsesdata.nsf.gov/doctoratework/2013/html/SDR2013_DST48.html (data table in What They Do pie charts.xls, NCSES 2013 tab)





SOURCE: *C&EN* 2014 SALARY SURVEY (SEPT 1, 2014))





SOURCE: *C&EN* 2014 SALARY SURVEY (SEPT 1, 2014))

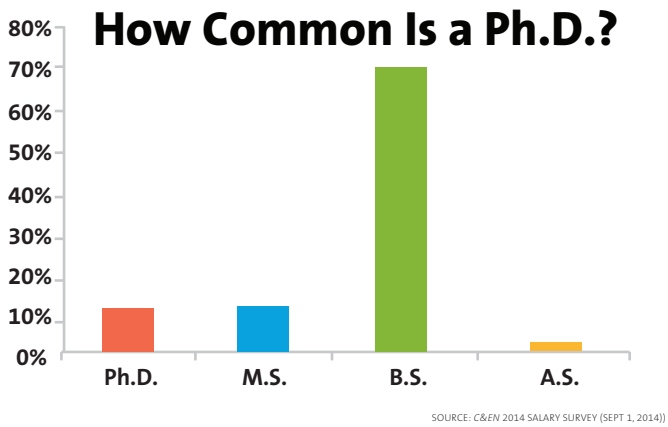
ing such a university's name on your diploma can be a valuable asset when you apply for your first faculty position.

Many smaller universities have invested significant resources in making themselves the premier graduate schools for specific fields, often connected to local industries. For example, they produce experts in coal, oil, and alternative energy sources, and others may offer elective courses in science writing and communications, business management, policy and regulatory affairs, intellectual property, and other careers outside the lab.

Goroff recommends researching the amounts that specific universities and degree programs pay for research and teaching assistantships, and comparing this with the local cost of living before choosing a graduate program. Graduate assistantships should be adequate to cover basic expenses and a simple lifestyle. If they don't, it could be a sign that a particular program might be underfunded, she notes.

Developing transferrable skills and career agility

Chemists who are well into their careers often note that the most valuable benefit they got from graduate school was "learning how to learn". These abilities will serve you well in any career, and they can make career transitions easier. Scientific fields evolve, job markets change, and most people make



SOURCE: *C&EN* 2014 SALARY SURVEY (SEPT 1, 2014))

several career shifts over the course of a lifetime. The process of getting a Ph.D. can make it easier to be creative in searching for jobs and applying your skills in unconventional ways.

Frankie Wood-Black, a lecturer at Northern Oklahoma College, put it this way: "Your credentials will get you in the door, but *you* have to decide if it's the right door." Wood-Black began her postgraduate career as an industrial research chemist at a petroleum refinery. She moved into regulatory affairs, which put her into close contact with the chemical engineers who worked in the plant. "My Ph.D. credentials gave me a lot of credibility when I was weighing in on the cost and feasibility of complying with various regulations," she said. After six years working for a consulting company, she moved into academia, where she is well situated to give her students career advice.

Wood-Black stresses that it's not wise to choose an area of specialization merely because it's a "hot" field. A field that's in high demand when you begin graduate school can cool significantly over the five to seven years it takes to get your diploma. On the other hand, new job areas like proteomics and 3D printing can pop up just as unexpectedly, and the job you get after graduation might not have even existed when you started grad school.

Running a business

Although doctoral programs traditionally have focused on preparing students for careers in academia, many programs are evolving to provide better preparation for jobs in industry, where most chemists work. Partnerships between industry and academia have flourished since the 1980 Bayh–Dole Act made it legal for universities to patent inventions and discoveries that their faculty members make using government grant money. Professors who invent new devices or chemical processes can work with their universities to obtain patents and start businesses to develop and market their inventions and discoveries. These faculty entrepreneurs can provide graduate students with advice and experience on running a business and bringing a new product to market.

Often, university faculty members run start-up companies in off-campus research parks, where businesses and university researchers can collaborate. This environment offers networking opportunities as well as a potential source of jobs after graduation. In the past 15 years, universities have begun to set up technology incubators and other types of partnerships right on campus, where students, faculty members, and entrepreneurs can interact on a daily basis.

Maximizing your return on investment

Getting a Ph.D. requires a large investment of time, effort, and research funds. The payoff comes in the form of job opportunities, skills that can be applied in a wide range of careers, a higher level of status and credibility among one's professional colleagues, and a higher level of income that makes up (over the long run) for the years spent on a tight budget. (See "Show Me the Money".) The size of that payoff and the amount of satisfaction you gain depend in a large part on how well you manage your investment. iC

Show Me the Money

According to the 2014 Comprehensive Salary & Employment Status Survey of ACS members in the workforce, 92% of chemists at all levels of experience are employed full-time. However, salaries in constant dollars are sliding: wages in 2014 in current dollars (not adjusted for inflation) are about the same as in 2013. Chemists who are not employed full-time are about evenly divided among postdocs, part-time workers, and those who are unemployed or seeking employment. A separate survey of 2035 ACS members who graduated with chemistry degrees between July 2012 and June 2013 revealed an unemployment rate of 14.9%, up from 12.6% in 2012. iC

What They Earn: Median Base Salaries 2014 Source: C&EN

Nancy McGuire *is a freelance writer based in Silver Spring, MD. She has a Ph.D. in solid state chemistry and began her career doing applied research.*

ADDITIONAL RESOURCES

National Center for Education Statistics. Tables generated interactively from a 2009 survey of 50 universities. http://nces.ed.gov/ipeds/datacenter/Data.aspx

National Science Foundation. Science and Engineering Indicators 2014. www.nsf.gov/statistics/seind14/index.cfm/appendix/tables.htm#c2

National Science Foundation, National Center for Science and Engineering Statistics, Survey of Doctorate Recipients, 2013. http://ncsesdata.nsf.gov/doctoratework/2013/index.html

National Science Foundation, National Center for Science and Engineering Statistics, special tabulations of U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey, 2001–10.

American Chemical Society, Department of Member Research and Technology. ChemCensus 2010. Issued July 25, 2012.

American Chemical Society. 2013 ACS Graduate Student Survey. www.acs.org/content/dam/acsorg/education/educators/reports/2013-ACS-Graduate-Student-Survey-Report.pdf

Susan R. Morrissey. Starting Salaries. Chemical and Engineering News, June 2, 2014, pp 28–30.

Sophie L. Rovner. 2014 Salaries and Employment. Chemical & Engineering News, September 1, 2014, pp 68–73.

University research parks and business incubators: Jana J. Watson-Capps and Thomas R. Cech, "Companies on Campus," Nature, 514, pp 297–298, October 16, 2014

Ph.D. Completion and Attrition: Analysis of Baseline Demographic Data from Ph.D. Completion Project; Council of Graduate Schools: Washington, DC, 2008. (cited in 2013 ACS Graduate Student Survey)

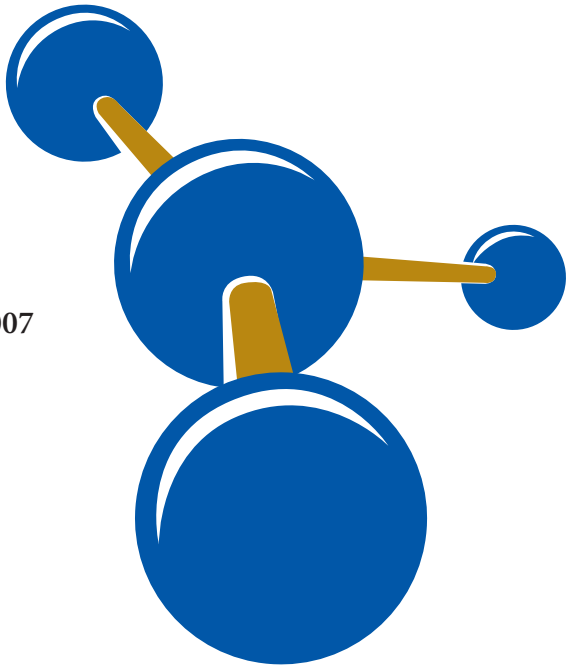
South Dakota State University

Graduate Studies

Chemistry & Biochemistry

Department of Chemistry and Biochemistry

Box 2202
Brookings, SD 57007
(605) 688-5151



SDSU

The Department

A medium-sized, friendly department with 16 faculty and 65 graduate students. New research and instructional laboratory facilities. Well-equipped core instrumentation facilities.

Degrees

Ph.D. and M.S. degrees in chemistry. Research specializations in Analytical/ Environmental, Biochemistry, Organic, Biophysical Chemistry, Biophotonics, and Chemical Education.

Financial Aid

All students admitted receive a full stipend and tuition remission.

Admission Requirements

Applicants should be nearing completion of a degree in chemistry, biochemistry, or related fields and have a B average or better.

For More Information

Phone: (605) 688-5151

E-mail: chemgrad@sdstate.edu.

Web: www.chembiochem.sdstate.edu or scan the QR code to visit our site.

The Hunt for a Greener Cleaner

How One Chemist Was Inspired to Launch His Own Company

BY ERIC STEWART

In 2013, Kevin Tibbs and his business partner, Tim Barklage, appeared on *Shark Tank*, a series featured on the ABC television network, which generated a lot of excitement for their Better Life brand and cleaning products.

For 14 years after earning his bachelor's degree in biology and chemistry, Kevin Tibbs enjoyed a satisfying career as a formulation chemist, working on skin care and cosmetic products at various companies, including Tyco, Bristol-Myers, and Steris Corporation. But when he and his wife had their first child, Tibbs recalls, "She changed everything."

When their daughter was a toddler, she developed asthma and very sensitive skin. "Her doctor was giving us advice about babyproofing our house," Tibbs explains, "and suggested that it would be better if we cleaned the house when our child was outside, so that she would not breathe the fumes. It suddenly hit me: if it's not good for a child to breathe the fumes, how could it be good for anyone else?"

"The more I read about the cleaning products industry," Tibbs says, "the more it seemed to me like it was broken. The types of consumer safeguards that were standard practice in the cosmetics and personal care products industry were missing. In fact, for many cleaning products, there is not even a requirement to list all their ingredients, as is the case with personal care products. But when we use these cleaning products, we can come in contact with the chemicals in very similar ways — including through contact with our skin, hair, and mucous membranes." In 2008, Tibbs left his job to launch a new venture: co-founding the company Better Life with his business partner, Tim Barklage.

Swimming with sharks

Tibbs's company, Better Life, has been growing rapidly since its founding, but within the past year, several developments have helped the company make an even bigger name for itself in the highly competitive household cleaning products industry — a field dominated by vast, multinational organizations.

Without a multimillion dollar advertising budget, however,

how can an upstart company like Better Life gain a foothold in such a market? For the first several years, Tibbs notes, marketing was largely through word of mouth. "Once we could get our products in people's hands," he explains, "they became huge fans." But getting to that point was very difficult.

The entire dynamic has started to change in the past couple of years, thanks to several fortuitous public relations and marketing wins. The first was a series of appearances on the Home Shopping Network (HSN), where Tibbs has served as a guest host — basically acting as his company's star pitchman. He has also traveled to various trade shows and sales presentations across the country to talk with buyers about his products' advantages and provide technical details regarding their formulations.

But things really started to happen when Tibbs was invited to appear on the ABC television show *Shark Tank*. The prime-time show gives a handful of entrepreneurs the opportunity to pitch their companies or products to a panel of venture capital investors — and in front of a national audience. Tibbs appeared on the show in 2013, and because it was one of the more widely watched episodes when it first aired, the network decided to rerun it a few months later.

"*Shark Tank* was a wonderful opportunity to pitch our product to some of the world's most accomplished businesspeople," Tibbs notes, "and it definitely created a lot of excitement for our company and brand." But at the same time, he explains further that it created a challenge, since the company's management didn't know what (if any) impact the appearance would have. "We really weren't sure," he explains, "whether sales would stay flat or increase by 10 or 20 times, or even more." As it turned out, Better Life saw a tremendous bump in sales on its website when the show first aired, and another bump when it was rerun.

Tibbs and his team have been busy pursuing other initiatives as well. For example, one of the most exciting developments is a trial distribution relationship with Target Corporation, which has agreed to offer Better Life products as a market test in 150 Target retail outlets. "It's obviously a huge opportunity for us," Tibbs shares, "with lots of market exposure to a group of consumers who very much align with our target demographic." The market test began with initial product shipments in August 2014, and if the test is successful the impact on sales and revenue for the company could be enormous.

Personal satisfaction

Tibbs is clearly ambitious, but unlike some entrepreneurs, he's not driven solely — or even primarily — by dreams of financial riches.

"After I started looking into the household cleaning products industry," he notes, "I was sure that I could make something that not only performed better than the existing chemical cleaners but was also safer for people and the environment. I was also sure that there was a tremendous market for this type of product — and that with my chemistry background, I could help fill a need."

Tibbs's career is a good fit for him, he observes, partly because it allows him to maximize his strengths. "I feel like I have a lot of creativity and the ability to solve problems. I also love the fast pace of business and not having to go through layers and layers of bureaucracy to effect change. It would be hard to think about going back to working for anyone else!"

Another aspect of the satisfaction he gets is simply from being in a position to create products that improve people's lives. For example, even though he admits to occasionally "getting a few butterflies" right before he goes on the air at HSN, "as soon as the camera starts rolling, I feel like I'm in my element. I actually find it fun and exciting to talk about our products — and there's nothing better than hearing a call from a customer who says that buying our products literally changed their life! When I hear that kind of feedback, it keeps me inspired and motivated."

Putting in time at the bench

Tibbs is not your typical industrial tycoon. He actually prefers to stay closely involved in the science behind his products, and works at the bench nearly every day. His typical day starts with

ACS Member Resources for Budding Entrepreneurs

Do you dream about starting your own business one day? ACS has a wealth of member-only resources to help budding entrepreneurs turn their dreams into a reality. Explore the ACS Career Navigator on the ACS website **www.acs.org/careernavigator** to find valuable information on starting and growing your own business, including:

- ACS Entrepreneurial Resource Center
- ACS Entrepreneurial Summit, which provides technical expertise, business advice, mentoring, customer services reviews, and discounted professional and legal services for six months to participants.
- Self-assessment tools, including a values inventory and experiences and strengths inventory.
- "Working for Yourself Career Pathways" course, which is offered at ACS regional and national meetings.
- Resources for developing a business plan, including key elements, a worksheet, and a business plan template.
- Applying for a patent.
- Getting funding and raising money.
- ACS Webinars on chemical entrepreneurship.

a brief status update from his operations staff and his assistant. After organizing his tasks for the day and communicating with and managing staff, he usually works for two or three hours either in his office or at his lab bench.

"I'm just as passionate about my work in the lab as I was on day one, and I'm in the lab easily 40–50% of the time. I still like to have my hands on all of our products, and I feel like they're each developed for me, by me."

On the other hand, Tibbs has learned that there are certain aspects of the work for which he needs the help of others. "For example," he explains, "I've always felt comfortable with the chemistry part of our company, but the business side is more challenging. My approach has been to go with my instincts, but to also surround myself with smart people who were good at those areas where I may not be as strong."

What's next?

Marketing initiatives are not the only areas where Tibbs's company is expanding and exploring. For example, Better Life recently installed a 60-kilowatt solar power generator for its factory, and is engineering new ways to increase efficiency and therefore lower the facility's power demands.

Better Life is also busy developing new products. "Last year, we introduced a new laundry detergent product," explains Tibbs. "Getting the chemistry right on it was actually a big challenge — but we've now perfected it, and we're planning to expand our laundry line with some unique products, including an improvement over traditional fabric softeners." Even more exciting, Tibbs notes, is the plan to expand their line of personal care products — soaps and lotions — featuring natural scents and botanical oils and extracts. If the effort is successful, Tibbs will have come full circle, back to the personal care products business in which he began his career.

Tibbs is inspired and driven by his work and his company's mission. "Across the board, we work very hard at making sure our products not only work better than other green products," he says, "but also outperform the traditional chemical products. And as we continue to grow, it's really important to keep looking for new opportunities." iC

Eric Stewart *is a freelance writer and editor living in Arlington, Virginia.*

Chemists in the Real World: Kevin Tibbs

B.S. PREMEDICAL, BIOLOGY, CHEMISTRY, TRUMAN STATE UNIVERSITY, KIRKSVILLE, MO

CO-FOUNDER/"MAD SKILLED SCIENTIST", BETTER LIFE

Kevin Tibbs, co-founder of Better Life, is also a featured chemist on the ACS College to Career website. To read his full interview, go to **www.acs.org/CollegetoCareer**.

How did you find your first chemistry-related job after you graduated from college?

When I graduated, it was a pretty tight job market, and I didn't have the work experience that many employers wanted to see. One of the places where I did manage to get an interview was a temporary placement service with a specific focus on scientific fields. I wasn't thrilled about the idea of taking temporary work, but shortly after talking with them, they let me know about a very interesting job opportunity at Bristol-Myers, which I took.

As it worked out, within six months of starting my temporary assignment, I had a permanent job offer with the company. In my opinion, it's important to realize that some companies use temporary positions as a way to try people out on a trial basis (with "no strings attached"), which means that if it's a good fit on both sides, there might be a permanent job offer!

Typically, how many days each month do you spend away from your workplace on travel?

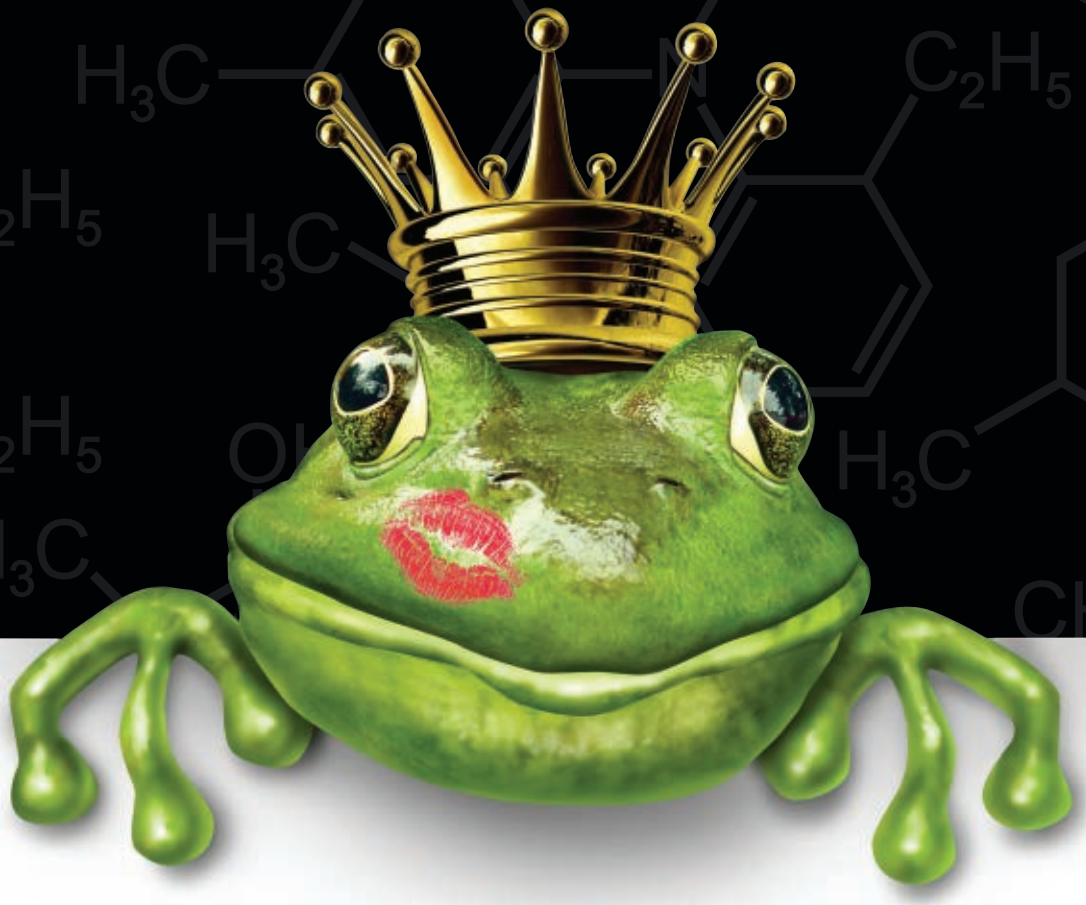
I usually spend between 6 and 10 days per month on travel. One of the things that takes me out of the office quite a bit is sales. I'm a guest host on the Home Shopping Network (HSN), where I periodically present our product line. I also go to various trade shows and sales presentations across the United States, talking with buyers about how our products are different, or providing details on a more technical level regarding formulations.

What's the best career advice you've received?

Do what you love, since you'll spend half your life doing it! For example, some people have the type of personality that lets them thrive when working at the pace of a smaller entrepreneurial organization. Others may be more suited for a large corporate setting. As a result, it's worth a little soul-searching to decide which is best for you. At Better Life, fit is very important — and we're very careful to make sure anyone we hire is the right fit for our company. It's very fast-paced, and each of our people has a lot of different responsibilities. Positions aren't as narrowly focused as they would be in a much larger company. iC

DISCOVER *the* Unexpected

Leap to the right choice for your career and future.



COLLEGE to CAREER
Getting a job in chemistry

ACS Chemistry for Life®

www.acs.org/college-to-career

SPOTLIGHT

Northwest-Shoals Community College

Phil Campbell, AL

COMPILED BY ROBIN LINDSEY

Chapter president: Brittany Millwood **Chapter members:** 28 **ACS student members:** 7
Institution description: Small, public, rural, 2-year

Q: **How did you celebrate National Chemistry Week?**

A: During NCW and the three weeks thereafter, ACS student members visited two to four elementary classrooms in our service area, presenting a 50-minute program of chemistry demonstrations and hands-on activities to the young students. We delivered a total of 23 presentations.

Q: **Is your chapter active in the recruiting efforts of prospective students to your university?**

A: We staff a display table of hands-on chemistry activities during each Senior Day and College Day event at the college, both of which bring busloads of students from the local high schools to our campus for a visit.

Q: **What is your most successful or interesting recruiting method?**

A: We sponsor an organizational meeting at the beginning of the fall and the spring semester to recruit interested students. Our chapter sponsors a steak picnic at the end of each semester for members and their friends.

Q: **What are some of your most popular or unique chapter activities?**

A: Each semester we cosponsor a Stargazing Party at the college observatory for students and their families. In the spring we sponsor a road trip to visit the University of Alabama and tour the nearby Mercedes-Benz factory. In January we offer a time management workshop, which features a lunch that includes two southern New Year's favorites, black-eyed peas and hog jowls.

Q: **Do you collaborate with other clubs on campus?**

A: We often cosponsor events and activities with the NWSCC Science Club and the college's Phi Theta Kappa Honor Society. We attend in large numbers all evening programs of the local ACS section (Wilson Dam Section), held nearby on the campus of the University of North Alabama.

Q: **Is there anything else you want the readers of *inChemistry* to know about your chapter?**

A: NWSCC has the only ACS student chapter in the entire Alabama community college system. Let's fix that! iC

PHOTO COURTESY OF NORTHWEST-SHOALS COMMUNITY COLLEGE

To recruit new members, the student chapter at Northwest-Shoals Community College sponsors a steak picnic at the end of each semester for members and their friends.

Faculty advisor:
Mike Murphy, 33 years

Q: **Why did you become a faculty advisor?**

Murphy: My involvement with science clubs goes back to my high school days, and it continues to provide an enjoyable way to meet people who appreciate science as much as I do.

Q: **What challenges have you faced in your position?**

Murphy: Ours is a commuter college, and scheduling activities that fit the students' busy schedules is difficult. iC

SPOTLIGHT

Canisius College

Buffalo, NY

COMPILED BY ROBIN LINDSEY

Chapter president: Jonathan Binns **Chapter members:** 80 **ACS student members:** 9
Website: www.canisius.edu/chemistry/learn/chemistry-club/ **Institution description:** Small, private, urban, 4-year

Q: **How do you ensure a smooth officer transition from year to year?**

A: We hold nominations for officers during our final general meeting, and members nominate a current chapter member for each officer position. All candidates are required to submit letters detailing why they wish to run, so that our members can make informed voting decisions. We encourage underclassmen to run for positions so that our executive board always has a mix of experience and new ideas.

Q: **How involved is your chapter on campus, and how do you collaborate with other clubs?**

A: Every year we host a football game between our ACS student chapter and Tri-beta, our college's student biology club. We have a long-standing and good-natured rivalry, which has led to several close games in the past few years. We always follow up the football game with a hearty lunch.

Q: **In what ways does your chapter give back to the community?**

A: We are always involved in our college-wide Community Day, where students give back to underserved parts of the community through volunteer work. For the past three years, our chapter has been involved with Habitat for Humanity. We also have a strong presence in local elementary schools; we frequently visit elementary and middle schools to perform chemistry experiments with young students to foster their interest in science.

Q: **What is the most effective communication tool that your chapter uses to promote chapter activities?**

A: We send e-mails, highlighting important dates and times with large, boldfaced, colorful type, as well as funny YouTube clips. We also rely on word-of-mouth communication between executive board members and faculty members, who then spread the word to chapter members and potential chapter members.

Q: **What is your most successful fundraiser to date?**

A: Every year, our chapter makes chocolate roses and sells them to the campus community during the week of Valentine's Day. It is a great way to make money, since buying chocolate in bulk is relatively cheap, the roses are easy to make, and they make a great Valentine's Day gift. In addition to fundraising, the event also fosters chapter bonding; we make the roses at a professor's house, and spending the day selling them is always a ton of fun. iC

PHOTO COURTESY OF CANISIUS COLLEGE

To celebrate Valentine's Day and raise funds, each year the Canisius College student chapter makes chocolate roses and sells them to the campus community.

Faculty advisor:
Phillip Sheridan, 7 years

Q: **How did you become a faculty advisor?**

Sheridan: During my first year at Canisius, my students encouraged me to attend several SCACS events. As the year continued, I found myself advising and helping the students with club activities. I enjoyed this outside-of-the-classroom interaction with the students, and so I volunteered to become the new faculty advisor the following year.

Q: **What challenges have you faced in your position?**

Sheridan: Finding time slots during the semester to meet with all of the chapter officers at the same time has been a perpetual challenge.

Q: **What has been the most rewarding aspect of your service as a faculty advisor?**

Sheridan: Working with the students and helping them to develop leadership and organizational skills. Being a SCACS faculty advisor has provided me with a great opportunity to interact with my students outside of the classroom and get to know them better.

Q: **What advice can you offer those new to the advisor position?**

Sheridan: Frequently communicate with your chapter officers. Let them know that you are there to help. Encourage fellow faculty members to attend chapter events; my students greatly appreciate that. iC

The Power of Partnerships: Fresh Ideas for Obtaining Student Volunteers

BY MICHEAL W. FULTZ

ALL PHOTOS USED IN THIS ARTICLE COURTESY OF MICHEAL W. FULTZ

After demonstrating that the density of gases will make a bubble filled with methane float while another filled with propane will sink, chapter members Jason Bloss and William Rollyson ignited the bubbles to make the experiment more memorable for the audience.

Our small ACS student chapter at West Virginia State University (WVSU) faces the usual challenges: recruiting students and alumni to run our outreach activities, securing adequate funding for events, and more. However, for the past few years, we have been forming unique partnerships to address these challenges, and through these partnerships we are nurturing a passion for science among the next generation of learners.

Our ACS student chapter has performed numerous Science Day events for area elementary schools. Among them are many Title I schools that otherwise would lack the infrastructure to maintain afternoon learning experiences without our assistance and participation. The ACS Division of Chemical Education (CHED) has helped us provide many focused activities for each school over the course of the academic year.

Typically, our Science Days involve two components. The first is a large-scale science demonstration consisting of activities that excite the children about science and involve volunteers from the audience. The second component is a series of educational hands-on activities in the classroom that complement the students' classwork. In presenting these activities, we have used a strategy that, based on discussions with colleagues at national and regional meetings, we believe to be unique.

Partnership power

To expand the pool of student volunteers, the WVSU departments of chemistry, biology, and education have partnered to provide these service experiences at local schools. We pair education majors with science content majors to foster unconventional partnerships. Many of our science majors are happy to perform the school service work portion of the experiments; however, they are often reticent about being the sole educator in charge of a classroom full of young children. The presence of an elementary education major, we've found, buffers and allays these feelings of intimidation. The education majors teach our science students how to teach science concepts and interact with children, and in turn, the education majors learn the science concepts. These future teachers experience the excitement that Science Days bring to children and, years later, we hope they will be encouraged to reach out to science professionals when they are considering how to present science concepts in their own classrooms. The future teachers also meet the science professionals of the future; after all, it's very likely that our chapter includes future doctors, pharmacists, technicians, and researchers.

The partnership between the WVSU Department of Education and our chapter provides many long-term benefits for the school systems in the area. "This is an opportunity for students in our department to see exciting science demonstrations and to think about activities that get young people excited about science," explains Brenda Wilson, a professor in the WVSU Department of Education.

Communicating to elementary school students that science is imperative for our society to successfully function creates an eye-opening revelation for them. Education major Emily Wood is a three-year ACS student chapter member and has visited numerous schools in the Kanawha Valley. She explains, "The outreach WVSU's ACS student chapter does has shown me how to get young

ABOVE: **A young student helps with the elephant toothpaste demonstration.**

RIGHT: **Member Katie Poole displays her National Lab Day button. Each year, the WVSU chapter takes part in community activities celebrating National Lab Day.**

students excited about the sciences before they lose interest in them. The experiments we do with the students often use household products and show the students that they are literally surrounded by chemistry and the sciences in general. This revelation shows students that science is relevant and gets and keeps them interested. I personally have used some of the experiments we do with elementary students with my high school students just to show them that chemistry is everywhere and to spark their interest. Our outreach program has taught me how important it is to make science relevant and to get students, especially young ones, interested in STEM [science, technology, engineering, and mathematics] fields."

Material support

To encourage current classroom teachers to conduct hands-on activities with their students, we provide each school with a copy of *Wonder Science*. These books are available through the ACS web store for about $45, and they provide more than 600 science experiments (requiring minimal equipment and expense) that teachers can conduct with their classes. These experiments include basic instruction on science concepts to help teachers explain activities and procedures. Many teachers have praised the book highly, saying it is an enormous and frequently used asset. Some of the schools we have visited do not have a science text for a particular grade; equipping them with *Wonder Science* is just one way that we can help address this void.

Helping students develop skills for science is important, but communication skills are also critical in scientists' future careers. Unfortunately, undergraduate and graduate faculty consistently describe their respective students' communications skills as weak. We help address this concern (in a modest way) by offering an essay contest that encourages elementary students to write on topics such as "What do you enjoy about science?" and "What did you enjoy about today's experiments?" ACS student chapter members review the papers to gauge and analyze each student's level of excitement, thoroughness, and writing style and then reward the top students by contributing science kits to their classes. The kits we use are donated to us by CHED and are also available by way of the ACS online store, as well as through several other online retailers.

It's worth noting that these are not "one and done" events. Follow-ups that provide each school with resources, conversations, and competitions are critical to outreach success.

Help with funding

Although we have been incredibly fortunate in many aspects, accomplishing and funding these activities with only a small group of volunteers is a challenge. We are lucky to have a strong alumni base and active community members whose generosity exceeds expectations. Stakeholders, like Dow Chemical Company, who have a vested interest in the education level of the future workforce here in the Kanawha Valley, have supported our efforts generously. These donors, in conjunction with money our members raise through fundraising activities, allow us to provide these much-needed services to local school systems at no charge.

The effect that we have in our local schools is best summed up by those working in the schools. Principal Barbara Black notes, "The partnership established between WVSU and my school has not only inspired students with hands-on experiments and exhilarating demonstrations but has also kindled a fire in my teachers about science."

Together with community and university support, the current and former members of WVSU's ACS student chapter work together to affect, encourage, and inspire tomorrow's scientists as they find their passion. iC

Micheal W. Fultz *is an assistant professor of chemistry and the ACS student chapter advisor at West Virginia State University.*

2015 ACS National & Regional Meetings

249th ACS National Meeting
March 22–26, 2015
Denver, Colorado

Great Lakes/Central Regional Meeting
May 27–30, 2015
Grand Rapids, MI

Northeast Regional Meeting
June 10–13, 2015
Ithaca, NY

Northwest Regional Meeting
June 21–25, 2015
Pocatello, ID

250th ACS National Meeting
August 16–20, 2015
Boston, MA

Midwest Regional Meeting
October 21–24, 2015
St. Joseph, MO

Southeast/Southwest Regional Meeting
November 4–7, 2015
Memphis, TN

Western Regional Meeting
November 6–8, 2015
San Marcos, CA

For more information about upcoming ACS national and regional meetings, go to **www.acs.org/meetings**

Other Meetings of Interest

Two-Year College Chemistry Consortium ($2YC_3$)
March 20–21, 2015 • Westminster, CO
May 22–23, 2015 • Kaneohe, HI
www.2YC3.org

National Organization for the Professional Advancement of Black Chemists and Chemical Engineers (NOBCChE)
September 22–25, 2015 • Orlando, FL
www.nobcche.org/conference

Society for the Advancement of Hispanics/Chicanos and Native Americans in Science (SACNAS)
October 29–31, 2015 • National Harbor, MD
www.sacnas.org

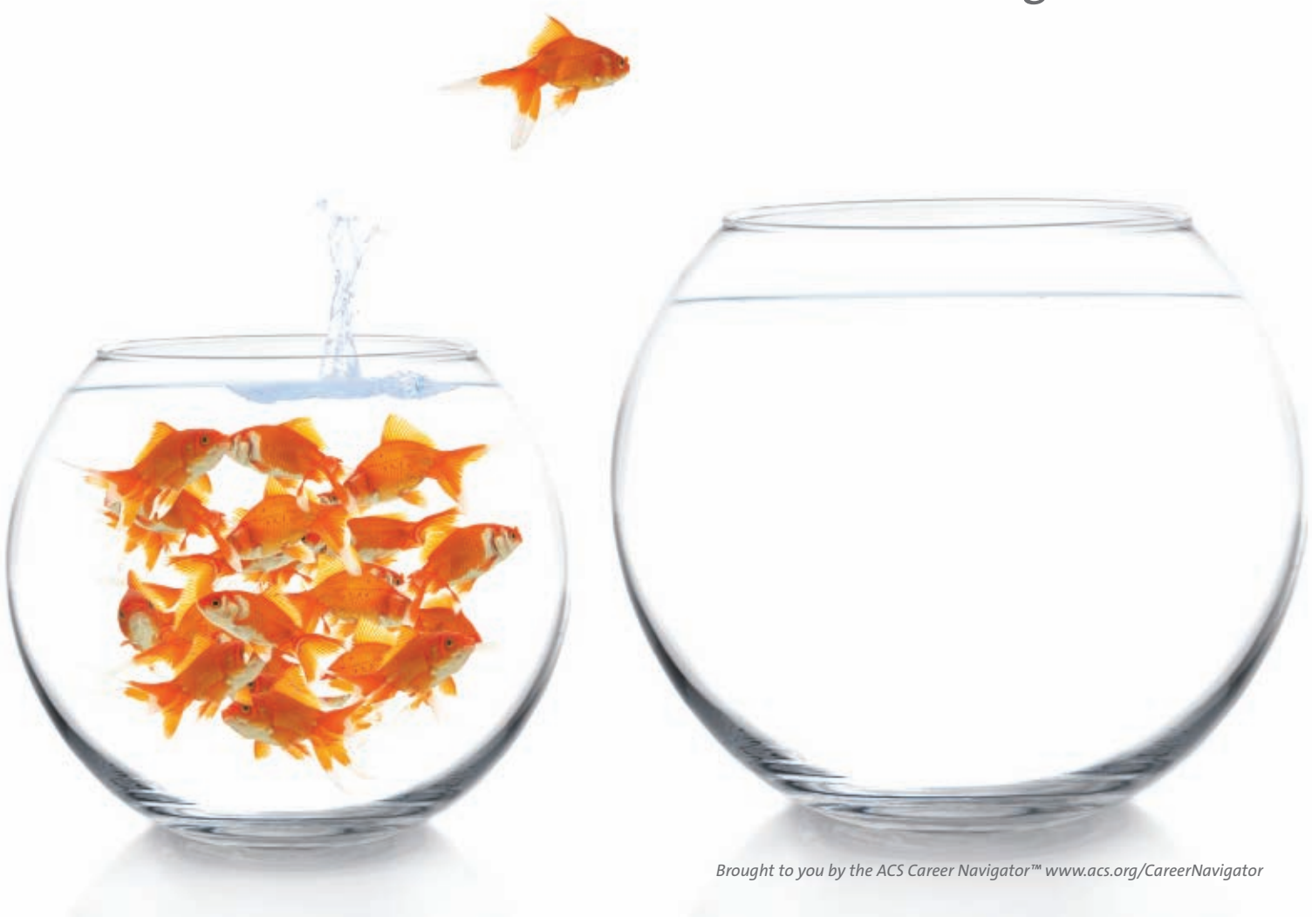
The International Chemical Congress of Pacific Basin Societies
December 15–20, 2015 • Honolulu, HI
www.pacifichem.org

ACS Chemistry for Life®

American Chemical Society

MAKE THE JUMP

The ACS Career Fair provides resources for you to confidently find a new job and stand out from the crowd. Visit ***www.acs.org/MaketheJump*** to get started.



Brought to you by the ACS Career Navigator™ www.acs.org/CareerNavigator

ACS Chemistry for Life®

American Chemical Society
1155 Sixteenth Street, NW
Washington, DC 20036