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**EDITORIAL**

Self-assessment is as important for a publication like Chemistry as it is for individual chemists. Individuals often look inward at themselves with an eye to starting or changing a career. They want a clearer picture of their strengths, skills, interests, and values.

Publications often self-assess by looking outward at their audiences. They want a clearer picture of how well the publication serves readers, what value readers place on the content, and what directions they should take in that ongoing process of meeting the audience’s information needs.

Chemistry recently completed a major readership survey, one of the standard tools that publications use to gauge their performance. The professionally done research included a random sample of readers selected from the ACS membership roster. We wanted to determine overall member perceptions of Chemistry, find out how much time they spend reading the publication, identify their favorite sections of each issue, and ask about preferences for the future.

Any publication would be pleased with the outcome.

Readers regard Chemistry as an important benefit of ACS membership. The majority read some or all of the publication. In these busy times, many spend an average of one hour on each edition. Many save, clip, or circulate their own copy to others. Members not only read to keep current with the chemical sciences, advance their careers, and learn about ACS news and activities. Many do so “just for fun.”

The survey did suggest a desire among readers who work in industry for more content relating to chemistry in that setting.

Readership research is not meant to be comprehensive. It’s a way to identify trends among ACS members and how best to serve them. The survey suggested a need for new content that members wanted and valued. The survey also reinforced the value of content that has been regular features, columns, and ACS news and advertisements that have made Chemistry a valuable benefit of ACS membership.●

—Michael Woods

Michael Woods (ACS ’96), editor of Chemistry, is a science journalist and author in Washington, D.C. His most treasured writing award is the ACS Grady-Stack Award for Interpreting Chemistry to the Public, named for News Service pioneers James T. Grady and James H. Stack.
Scientists and students heading for Europe face financial pain from a U.S. dollar that is losing value against foreign currencies and everyday high prices. The crunch is no reason to turn down work or study abroad, but every reason to prepare in advance.

Inflation is a major concern for scientists—and many other people—in the United States. Pundits debate whether the cost of living is rising faster now than it has been over the past three years. But for anyone who works or studies in Europe and gets paid in dollars, there is no debate. The cost of living definitely has soared over the past three years; it may continue to skyrocket over the next couple of years.

The culprit is not inflation, but the weak dollar, the value that currency traders give to the U.S. greenback relative to monies from other countries. That value has been sinking since 2002, so that today a dollar is worth approximately 40% less than the Euro (€) and about 30% less than the British Pound (£). Some experts predict that the dollar could sink another 20% or more by the end of 2006.

Twenty percent. Forty percent. What does that mean in real terms? Let’s say you had a yearly stipend of $25,000 in 2002, when the Euro was born. That would have been worth about €27,800. Even if you’d gotten a 3% raise each year between now and then, that $25,000 stipend would be worth only about €21,800. In essence, you’d have taken a €6,000 pay cut. With no raises, you’d be getting about €20,000. Ouch! Feel the pain.

Fortunately, price inflation is expected to remain tame in Europe, so you won’t be getting the double whammy of rising prices combined with what’s effectively a falling salary. Even if you got another 3% raise next year, your effective earnings could fall another €6,000 by the end of 2006.

Everything Is Expensive

Then again, the cost of living in most European cities already is inflated compared to that in the United States. London, for example, is considered the most expensive city on the planet. According to data from the Mercer Human Resource Cost of Living survey, which many companies use to adjust salaries as they move employees around the world, it costs 19% more to live in London than in New York; 41% more than San Francisco; 50% more than Boston or Washington, DC; and 80% more than Pittsburgh. The cost of living in Paris, Geneva, Zurich, Milan, Dublin, and Stockholm is only marginally lower than that in London.

“Everything costs more here,” said Eliot Marshall, an editor at the journal Science, who recently moved with his family from Washington, DC, to London. “Until I saw for myself, I hadn’t believed English friends who said that the easy way to calculate the price of shopping in Britain is to imagine what it would cost in the United States and double that number. Even toothpaste is twice as expensive.”

As regular readers know, I’m a big proponent of working overseas, and I don’t want to discourage anyone from seeking educational and employment opportunities abroad. The career benefits will far outweigh any short-term damage to your standard of living. If you’ve been a graduate student or postdoc, you’re used to living on the cheap, so figuring out how to do so in Europe will make use of skills you already have.

Bring What You Can

However, be aware of the wilting dollar and Europe’s pricey environment. That stipend or salary may buy much less than you imagine. Check with funding agencies and employers, for instance, about cost-of-living adjustments, or being paid in the local currency.

There are many ways of economizing in Europe.

Forget about owing a car, for instance. Public transportation is excellent and reasonably priced in Europe. Remember that a gallon of gas can top $6 and parking can be scarce. Erin Esko recently graduated from the University of California, Santa Barbara, and now works in Barcelona. Esko economizes on food by shopping in those wonderful outdoor markets.

Housing costs are rarely cheap in Europe. Look for an apartment that includes all utilities, and expect to live small because apartments and houses in Europe are small. You’ll need less stuff, and that will save you money as well. Laptop computers, stereos, MP3 players, digital cameras, USB drives, Secure Digital cards, and other consumer electronics products carry sticker-shock prices.

CDs and DVD movies cost 30–50% more than they do in the States. You’ll also pay substantially more in Europe for most products made from cloth or paper, including clothing, bed linens, bath towels, and books. With the unfavorable exchange rates and higher prices, here’s a good general rule: Bring whatever you can from the United States.

Yes, moving to Europe will be a financial shock. But think how wealthy you’ll feel when you return to the States.

Joe Alper (ACS ’97) lived the life he writes about as Chemistry’s Global Perspectives columnist. He held chemistry jobs in London and Paris before returning to the United States and a career as a noted freelance science and medical writer in Louisville, CO.
In fall 2004, ACS undertook a member satisfaction survey to more fully understand your needs and to ensure that ACS remains the premier professional home for all practitioners of the chemical sciences. The Society serves individual members with a myriad of programs, products, and services to advance the profession and we wanted to know how we are doing.

In this column, I am pleased to provide an update on what we learned from the survey, what our subsequent steps have been, and how we will continue to study and respond to your needs and expectations.

First, a few words about the study itself. We selected a random sample of 3,542 ACS members who had e-mail addresses. All respondents could participate by mail, Internet, or telephone interview. Sixty percent of the members who received a survey responded. Survey experts consider this to be an excellent response rate.

Overall, members view the Society very favorably—85% of respondents said they are satisfied, and only 5% said they were not satisfied. Nearly all our members would recommend ACS membership to a colleague.

Members are especially satisfied with our technical publications. The ACS Publications program is a robust and dynamic part of what our organization accomplishes and members recognize our commitment to publishing high-quality science. Members are similarly satisfied with market intelligence (such as salary and employment surveys, including the member-only Salary Comparator), helping develop knowledge about emerging interdisciplinary areas, improving education in the chemical sciences, and the recognition ACS provides to members.

Also singled out for praise were programs focused on Green Chemistry and efforts to reduce pollution and preserve the environment as well as ACS's efforts to foster federal investment in chemical research and inform the public about the chemical sciences and their contributions to society.

The most used ACS services are Chemical & Engineering News, the ACS website, technical publications, salary and employment information, ACS National Meetings, and Chemical Abstracts Service products, such as SciFinder and SciFinder Scholar.

We also asked members to tell us where we could do better. There were items of high importance where members were not as satisfied, all of them centered on employment. These include: career services that could help with unemployment or job change, workshops, career consulting, employment information, and assistance to support member careers. To more fully understand your needs, we conducted focus groups over the summer. We continue to review and evaluate services in the careers area, and we are exploring a variety of new ways to deliver those programs.

To maintain our status as the finest organization for the chemical sciences, we know we must also plan for future member services. When asked about possible new programs, members topped their list with a unified search engine for all ACS information. They also wanted services focused around their own work specialties (i.e., learning opportunities at low or no cost and an ACS website organized with news and information in their area). The survey emphasizes that the ACS website is key to attracting new members and satisfying our current members.

Since March, we have made major progress on our three-year project to reinvent the ACS Web presence. The Web reinvention process will truly reinvigorate ACS and help us immensely with our member value proposition, especially in our ability to attract younger and interdisciplinary scientists to ACS.

Many of our members told us that they are also interested in more interaction with international colleagues. A number of governance committees also have indicated that ACS should expand its international presence. To explore future international collaborations, an ACS delegation traveled to China in April to visit with high-level university, industry, and government officials. Also, plans have been laid for a major international conference in India in January 2006. This fall, we will conduct a non-U.S. member survey to help us determine where our services best meet international needs.

So, now that we know what members value, where we're meeting your expectations, and where we're falling somewhat short, what will we do? The Society's staff and governance are currently undertaking a review of ACS programs to ensure that the Society's services satisfy our members. We also recognize that ACS must be agile in its business practice and nimble in its decision making. To that end, the ACS Board and Council are undertaking a comprehensive review of the Society's governance structure.

Most importantly, we are listening to you to understand what you value most about your membership and how we can continue to add to that value as the world and your professional needs change. ACS has a strong commitment to serving our members, the profession, and representing the importance of chemistry to the public. Through annual member surveys we will continue this ongoing dialogue as we build the Society of the future.

As always, we seek your comments, and I'm looking forward to hearing from you. Write to me at executivedirector@acs.org.

Madeleine Jacobs (ACS '96)
Executive Director & CEO

P.S. My special thanks to Bruce Millar in the Membership Division, who contributed to this column.
Minced Matters
Thanksgiving will be here in a flash. Anyone looking for a really old-fashioned holiday dessert might consider minced meat pie.

Dessert?
Minced pie went meatless long ago, becoming a fruity mix that includes raisins, currants, dates, and spices. Vegetarians beware: The ready-made pie filling may contain suet, which is animal fat.

The Royal Society of Chemistry (RSC) in the United Kingdom is offering a recipe for "Sir Robert Boyle Minced Meat Pie." RSC unearthed a 350-year-old recipe for the real stuff from the England of Sir Robert, whose family established Piccadilly's Burlington House, home to RSC and other learned societies.

A real minced meat pie in the 1640s contained chopped beef and often an assortment of other meat and poultry.

"Tastes changed, and by the 18th Century, a division was emerging between 'sweet' and 'savory' that would be recognized today," noted Anne Murcott, who discovered the original recipe. "Mostly, savory meat pies lost their sweet flavoring. The exception was the mince pie which, instead, lost its meat, though it retained an ingredient of animal origin in the form of suet."

David Giachardi, chief executive of RSC, last year began offering the Sir Robert Boyle pie as a holiday treat to staff members, "in memory of the man who founded chemistry." What about Joseph Priestley?

"Boyle showed that chemistry was worthy of study as its own subject and he applied fine experimental and quantitative methods, which are qualities that top chefs admire and emulate in their own work," Giachardi said. "After all, cooking is merely chemistry applied to food."

One traditional recipe: www.ehow.com/how_7000_make-mincemeat-pie.html

Going Through Phases
Materials that undergo changes from the amorphous to the crystalline phase are mainstays of optical storage media such as DVD rewritable discs. In DVDs, heat from a laser switches the material between amorphous and crystalline phases, causing a change in reflectivity.

The same phenomenon has quietly become an exciting new computer memory technology that promises to snare one of the field's holy grails. Called phase-change memory (PCM), it stores data in a material's state. An amorphous state represents a zero and a crystalline structure represents a one.

PCM offers several advantages over flash memory technology, used in Secure Digital cards for cameras and USB or "keychain" drives for computers. It is faster and more reliable, for instance, and new data can be written to PCM without first erasing old data. Like flash memory, PCM is "nonvolatile," retaining data after the electricity is shut off.

Scientists at Philips Research have reported a doped antimony/tellurium phase-change material that works at the lower voltages needed for practical applications. An electric current switches the material between phases and then detects the resultant change in electrical resistance. The material can be programmed 100–200 times faster than flash memory.

"The holy grail of the embedded memory industry is a so-called unified memory that replaces all other types," said project leader Karen Attenborough. "Philips' new technology is a significant step towards this goal."

MEASURING PERFORMANCE of Phase Change Memory
Waggle Dance

Karl von Frisch, the Nobel Prize-winning zoologist, sparked one of science’s great controversies in the 1960s by proposing that honeybees communicate with a kind of dance language called the “waggle dance.”

The buzz: A worker who discovers a good feeding site informs her hive-mates through a dance that describes the distance and direction of the feeding site. Other workers observe the dance and fly off to the site.

Some scientists pooh-poohed the hypothesis. They argued that bees didn’t read any abstract code in the dance at all, but found the food source by tracking down odors from the dancing bee. Others suggested that bees simply followed the dancer when she flew back to the food.

Joseph Riley and co-workers at Rothamsted Research in the United Kingdom may have settled the dispute. They used harmonic radar to show that bees do translate the dance code into successful navigation.

The scientists observed waggle dances in a glass hive, identified the spectators or “recruits,” captured them as they exited, attached a radar transponder, and then tracked the bee flight paths with radar.

Nano Valve and Master Nano Plumber

Nanotechnology has yielded an array of tiny motors, gears, gear trains, shafts, and microelectromechanical systems (MEMS).

Chemists at the University of California at Los Angeles now have added the first nano valve that can be opened and closed like a faucet to trap and release molecules. The valve has potential applications in new drug-delivery systems small enough to work inside living cells, according to Jeffrey I. Zink, a professor of chemistry and biochemistry on the research team.

“With the nano valve, we can trap and release molecules on demand,” Zink said.

The valve’s moving parts are switchable rotaxanes, molecules composed of a dumbbell component between which a ring component can be made to move back and forth in a linear fashion. They are attached to a tiny piece of glass (porous silica), which measures about 500 nanometers and has pores a few nanometers in diameter.

“It’s big enough to let molecules in and out, but small enough so that the switchable rotaxane molecules can block the hole,” Zink said. The rotaxanes’ movable component blocks the hole in the down position and leaves it open in the up position. Energy from a single electron is the power source.

The team’s first valves leaked a little. Zink described graduate student Thoi Nguyen as the “master nano plumber” who discovered how to plug the leak and make the valve close tightly.

On the team’s research horizon: tests to see how large a hole they can block, to determine whether larger molecules, like enzymes, will fit inside.
Research Need: Gum Control
Chewing gum resembles flavored, sweetened, synthetic rubber. The polymers that give gum a pleasant, chewable texture in the mouth produce those gross blotches on sidewalks when thoughtless consumers litter.

It has created a little-recognized R&D need—for a biodegradable or non-adhesive chewing gum.

Gum control is a sticky problem for cities, where armies of workers use high-pressure sprays and special solvents on polka-dotted sidewalks. Cities are introducing or considering stiff fines for gum litterers, per-pack taxes to defray cleanup costs, and sterner measures. In the 1990s, Singapore banned chewing gum.

The problem is getting worse with the bubble in gum sales, which have grown 27% worldwide in the last 5 years compared to 7% for candy. To make disposal tidy, more gum is being sold in tablets with no individual wrappers.

Earlier in 2005, the Wm. Wrigley Jr. Company, which sells wads of the world’s gum, obtained patent No. 6,858,238 for a biodegradable gum. It’s made from prolamine, a protein found in corn and other grains, with polyester added to provide softness. When spit out, the gum becomes brittle and easier to remove in the short term before degrading.

Graciela W. Padua and associates at the University of Illinois at Urbana-Champaign are working on another biodegradable gum based on corn protein. It emerged from research on corn-based, biodegradable plastics for packaging and agricultural applications.

Further improvements in taste and texture could lead to marketable products.

Tweaking Tetracycline
The emergence of antibiotic-resistant bacteria (please see Chemistry vs. the Superbugs, page 34) forces pharmaceutical chemists to constantly search for new antibiotics, sometimes by tweaking the structures of mainstay drugs like tetracycline and erythromycin. It’s a daunting task because antibiotics have very complex structures.

Despite 50 years of research, all useful tetracyclines, for instance, are either natural products or semisynthetics, in which the natural product was isolated and then modified.

Chemists at Harvard University now have reported a new route to synthesis of a broad range of structural variants of tetracycline, including at least one analog that appears to be superior to existing compounds. Mark G. Charest (ACS ’98) and associates in the department of chemistry and chemical biology scored the synthetic tour de force with a 14- to 15-step process that begins with benzoic acid.
CHEMICAL GENEALOGY HAS NOTHING TO DO WITH SYNTHESIS and precursors. Instead, it’s a type of academic and professional genealogy. It’s based not on blood relationships, but on educational and intellectual ones, typically through Ph.D. advisers and other mentors. Hosted by the University of Illinois at Urbana-Champaign, this site records the intellectual bloodlines of more than 1,500 chemists, going back in some cases to the Renaissance. An alphabetical index guides you to a brief entry with the individual’s name and the name(s) of his or her students and others whom that person influenced. A tree symbol, if present, links to a descent tree. For each person in the database, there’s a PDF file with birth and death dates, the highest non-honorary degree and its date and place, the person’s degree adviser, and his or her scientific accomplishments.

Linus Pauling and the Nature of the Chemical Bond

oslibrary.orst.edu/specialcollections/coll/pauling/bond/index.html

WHEN LINUS PAULING BEGAN TEACHING AT CALTECH as a brand-new assistant professor in 1927, he had just finished a Guggenheim Fellowship in Europe. Learning about the then-revolutionary discipline called quantum mechanics from its founding fathers roused such a passion in Pauling that he considered switching from chemistry to physics. Fortunately, he didn’t—and instead used his new-found knowledge to solve landmark questions about the chemical bond. Pauling went on to create his own revolution in chemistry, of course, with his theories about chemical bonding. In 1954 he received the Nobel Prize in chemistry. This site chronicles that remarkable journey with more than 800 scanned documents including lecture notes and letters, photographs, audio clips, and video excerpts, mostly drawn from the Special Collections at Oregon State University.

Chemical Genealogy Database Homepage

www.scs.uiuc.edu/~mainzv/Web_Genealogy

Chemical genealogy has nothing to do with synthesis and precursors. Instead, it’s a type of academic and professional genealogy. It’s based not on blood relationships, but on educational and intellectual ones, typically through Ph.D. advisers and other mentors. Hosted by the University of Illinois at Urbana-Champaign, this site records the intellectual bloodlines of more than 1,500 chemists, going back in some cases to the Renaissance. An alphabetical index guides you to a brief entry with the individual’s name and the name(s) of his or her students and others whom that person influenced. A tree symbol, if present, links to a descent tree. For each person in the database, there’s a PDF file with birth and death dates, the highest non-honorary degree and its date and place, the person’s degree adviser, and his or her scientific accomplishments.

EqWorld: The World of Mathematical Equations


EqWorld aims to present “extensive information on ordinary differential equations, partial differential equations, integral equations, functional equations, and other mathematical equations.” Does it! With more than 1,100 pages, the site (based at the Institute for Problems in Mechanics at the Russian Academy of Sciences in Moscow) covers science’s most important mathematical equations and solutions. It is also packed with information about handbooks on equations, brief descriptions of various methods for solving equations (with specific examples), exercises on methods for solving equations, and multitudinous links to mathematical websites, journals, and books. To access all this, a good starting point might be the Equation Index, which lists nearly 200 named equations. And for other questions, click the links for Ask a Mathematical Expert.
Decomposition: What Happens to the Body After Death
www.deathonline.net/decomposition/index.htm

The TV series Crime Scene Investigation (CSI) has eased sensibilities about once-yuck topics like this. At this very explicit site, visitors discover the interplay of the body's biological and chemical processes at the end of life. Skin cells, for instance, take much longer to die than muscle cells; environmental conditions can confuse CSI types (read how an electric blanket almost let a murderer get away); and insects can give clues about the time of death (including the charmingly named flesh fly and ham beetle). One section follows a pig from initial decay (through day 3); to putrefaction, where the body is bloated with gases (days 4–10); to black putrefaction, after the body collapses (days 10–20); to butyric fermentation (20–50 days post mortem); and finally to dry decay. The appeal of this singularly unappealing subject, of course, is that we've all seen one of those “CSI” technicians on TV pick up some bug with tweezers and sagely explain how it establishes time of death.

How Stuff Works
www.howstuffworks.com

A recent top item at this site was the Bugatti Meyron, a million-dollar sports car with a 1,000 horsepower, 16-cylinder, four-turbocharger engine that spells 250 miles per hour. With a zero-to-60 time of three seconds, this road rocket is exactly what you'd expect at such a fascinating site. But the better part is that the “stuff” here runs the gamut from Computer Stuff and Auto Stuff to Home Stuff (how grills work), Health Stuff (how West Nile virus works), Travel Stuff (how gas prices work), and more. There's a simple tutorial on picking locks, and even a tongue-in-cheek primer on Star Wars vintage light sabers (along with some important safety tips). Though rather generously laced with ads, the site also features plentiful links to news stories, such as one on the National Ignition Facility, a laser fusion project at Lawrence Livermore National Laboratory, and one on high-tech currency detectors, which might prove useful in curbing drug trafficking.

Scott Baltic is a magazine editor and freelance writer based in Chicago who often writes the Chem.WWW column. Scott finds those assignments among his most interesting, because he constantly discovers useful websites to add to an ever-growing list of favorites.
Maps of Where You’ve Traveled
http://douweosinga.com/projects/visitedstates

You're never too old to make a map of all the states you've visited, and this site makes it easy. The site can also be used for mapping other state traits, such as those that are Democratic or Republican. For the same concept with a worldwide approach check, http://douweosinga.com/projects/visitedcountries.

New York Times Best Seller Listings
www.hawes.com

From The Last Time I Saw Paris by Elliot Paul, the very first New York Times number-one nonfiction best seller back in August 1942, to the latest blockbuster novel, this site has all the NYT number ones, as well as a complete listing of best sellers back to 1994. There are also synopses of some books. Time to catch up on your reading.

Molecular Expressions: Exploring the World of Optics and Microscopy
http://micro.magnet.fsu.edu

Hosted by Florida State University, this site celebrates photomicrography with images both serious and light. Check out your birthstone—or any of scores of beers from around the world. The site includes good explanatory text. And check out the shop, too, especially the vitamin-themed bed linens.

All Kinds of Sounds
www.getrelaxed.com

If the sounds of seagulls or wind though the pines bring you back to that great getaway you took, this site is for you. Though sounds like Traffic or Alarm Clock arguably belie the site’s name, GetRelaxed is more versatile and certainly cheaper than those commercially available gizmos that do the same thing.

AMA Online Doctor Finder
http://dbapps.ama-assn.org/aps/amahg.htm

If you're looking for a new doctor or want to check out a new one, the American Medical Association's Physician Select site can help. Search a database of nearly 700,000 licensed physicians in the United States, by location, name, or medical specialty, from Allergy to Urology. You'll get the doctor's contact information and qualifications.

The Molecular Level: Tools for Structural Biology Education and Training
www.usm.maine.edu/~rhodes/index.html

Opsins are the proteins in retinal cells that convert light into electric impulses. They star in one of this site's tutorials on bioinformatics for beginners. That's just one of its many resources for assisting both students and instructors of structural biology, which seeks to understand the function of biological molecules by studying their 3-D structures.

Elemental Data Index
www.physics.nist.gov/PhysRefData/Elements/cover.html

Call it the periodic table on steroids. One click gets you atomic weight, ionization energy, ground-state level, and ground-state configuration. Your next click potentially brings access to nearly 20 databases at the National Institute of Standards and Technology's Physics Laboratory, including spectroscopic data, half-life measurements, and ionization cross-sections.

The Merck Manual
www.merck.com/mrkshared/mmanual/home.jsp

Because it's sold on a nonprofit basis, a hard copy of The Merck Manual of Diagnosis and Therapy: 17th Edition will set you back only $40, but having to lug around the 2,800-page volume might cause its own injuries. Instead, try this completely searchable online version of the book reputed to be “the most widely used medical reference in the world.”
Nano Hits

Discontinued Items
www.discontinueditem.com
A directory of discontinued and hard-to-find items, from fragrances to dinnerware.

Aurora Central
www.geo.mtu.edu/weather/aurora
A chance for everyone to appreciate the beauty and the science of the Northern Lights.

Intro to Online Games
www.i-am-bored.com/bored_link.cfm?link_id=8549
A sampler of online games, including a forehead-slapingly realistic version of miniature golf.

Everything about Chess
www.chessbase.com
All chess, all the time, from tournament news to tactical lessons from championship games.

Free Stuff A–Z
www.thefreesite.com
“Home of the Web’s Best Freebies:” Freeware, free image hosting, product samples, language translations, and more.

Baby Boomer Quiz
www.boomernet.com/boomquiz.htm
Twenty key questions to see if you’re really a Baby Boomer.
Career Coaches

Career coaches have been all but ignored by chemists. Many chemists assume only someone who knows chemistry could help them in their job search. What they don’t realize is that coaches give more than career advice. They help clients to tap into their dreams and sometimes to overcome the personal problems that put those dreams out of reach.

Ask a career coach about the last chemist he or she coached and you’ll probably draw a blank stare. Though they have held the ladder for practically every climber in a three-piece suit, these facilitators have all but escaped the notice of ladder-climbers in lab coats.

“Most people don’t associate coaching with chemistry,” said Jura Viesulas, the manager of employment information for ACS. “I think there’s a thought pattern in chemists’ minds that the only person who can help them is a chemist.”

That notion stems partly from confusion over what a career coach does. Until about 15 years ago, the only folks who called themselves coaches worked with jocks. People who wanted advice about finding a job went to a career counselor. Counselors still provide the skills assessment and job-search advice they’re known for. Coaches, on the other hand, see themselves more as advocates who delve into their clients’ dreams and show them how to reach them.

“A coach inspires,” said career coach and author Jay Block of Florida. “A coach empowers. I help people identify what their values are and then identify career options.”

ACS has offered its members discounted career coaching for the past 16 months. When asked about members who’d used the service, though, Viesulas could recall only the few who had been coached through the ACS coaching service, part of a suite of products, “Advanced Career Tools,” at chemistry.org/careers.

Even the discounted rate of $224 for three 30-minute sessions seems high to anyone who’s out of work. Members may consider the service particularly frivolous when they can get career counseling free from fellow ACS members. Since 1989, the Society has offered informal career advice through experienced members.

More than Counseling

For some job-seekers, though, a colleague’s networking tips and résumé critiques just aren’t enough. They need professional help to overcome emotional roadblocks that stand between them and a job.

“I don’t think chemists are any different from other people,” said Massachusetts-based career coach Alvah Parker. “Some would really enjoy having someone to just unload their concerns.” Unload is what Charles Hofmann (ACS ’91) did after choosing Parker from among a dozen coaches who offer their services at a discount to ACS members. The 58-year-old Pennsylvania chemist had thought he would spend his professional career working for Rohm and Haas, a mid-size chemical company, until a layoff three years ago shattered his plan. He’s been looking for a permanent job since then.

“She helped me get over the frustration,” Hofmann said of Parker. “After we talked about things I’d gone through, my confidence came back. I was ready.”

Hofmann tried to turn his temporary position at a major pharmaceutical firm into a permanent job while he studies at Temple University to become a high-school chemistry teacher.

Like Hofmann, Massachusetts chemist Juchui Lin (ACS ’75) relished his career coach’s compassion. The 58-year-old Ph.D. received free coaching after a company where he’d worked for 20 years downsized.

“The career coach will listen to your story and try to refocus on what is the right thing to do next,” Lin said, adding that the coach both helps you focus on managing your career search as a project and advises you about leaving the emotional factor out of the equation. He continued, “It had a good therapeutic effect. There are certain things you probably don’t want to discuss with your friends or family members.”

Lin felt that “meeting” his coach by phone, as most clients do, made him feel more comfortable opening his soul than he would have sitting face to face.
Finding the Right Chemistry

Lin and Hofmann chose their coaches from brief bios posted on the ACS website. Here job seekers can check a potential coach's qualifications. Career coaching has no education or licensing requirements. Most coaches, though, have taken coaching courses and passed an exam from at least one of several organizations. The most popular is the International Coach Federation. Another is the Professional Association of Résumé Writers & Career Coaches.

If you're looking for a coach, also consider his or her education and work history. Hofmann chose Parker when he read that she's a former high-school chemistry teacher, a career he hopes to pursue in a couple of years.

Ask a potential career coach for references, particularly from clients with goals similar to yours.

More than anything else, look for a coach you like.

"If you really believe your coach can help you, you will be helped," Parker said. "The relationship is the important thing."

Cynthia Washam is a freelance writer who confesses she knew nothing about career coaches until she started researching this article. She lives with her husband and son in Jensen Beach, FL.
Starting a new SA chapter, or reactivating a chapter that has been dormant for years, is only the first step. Often more difficult is the task of nurturing the student interest, excitement, and commitment needed to sustain a chapter and make it flourish.

When David Weiss (ACS ’92) joined the chemistry faculty at the University of Colorado at Colorado Springs in the fall of 2001, he found a near-dormant Student Affiliates (SA) chapter.

Weiss, then 31, wanted to energize his department and conveyed that enthusiasm to his students. The following year, several students asked him to help revitalize their chapter. “As a new professor, the students could see I was sort of motivated to get to know them,” Weiss said. “They wanted to have more of an interaction with faculty.”

Weiss used the SA chapter to fill that need, working with student leaders such as chapter President Chris Anderton to rekindle enthusiasm for chapter activities. They’ve organized pizza parties and trips to national meetings of the American Chemical Society. They’ve held “Cool Science” events where they performed chemistry magic shows for elementary school students.

Their hard work reaped rewards: During the 2003–2004 school year, enrollment at the chapter jumped from 22 to 41 Student Affiliates.

Mobilizing Commitment

Sometimes starting or reactivating an SA chapter is the easy part. Much harder, faculty advisers say, is nurturing enough student interest and commitment to maintain a successful chapter over time. But with commitment, patience, and a few innovative recruiting techniques, fledgling SA chapters can flourish.

“When students really realize what it takes to run an organization, they can get overwhelmed,” said Tracey Willis, the SA adviser at Texas Southern University, which reactivated its chapter during the 2003–2004 school year. “You might have to kind of work with them to pull that leadership ability out of them.”

Last year, Texas Southern and its Student Affiliates participated in National Chemistry Week for the first time, hosting a Health and Wellness Fair and using vitamins to show connections between chemistry and health. When students “actually see the activities occurring, you increase [membership] that way,” Willis said.

The chemistry department paid for chemistry majors’ membership the year the chapter restarted. Membership has dropped somewhat now that students have to come up with $25 on their own, but Willis draws new recruits by spearheading a membership drive at the start of each semester.

Willis and SA leaders talk to chemistry classes, particularly targeting freshmen who’ll be able to contribute for years. She gets other faculty members involved with chapter activities and seeks collaborative opportunities with other campus organizations.

Fostering a Sense of Belonging

At the University of Colorado, Weiss and his SA officers also recruit new members from chemistry classes, announcing chapter events and performing demos for their peers. “Student retention is really linked to students feeling part of the department,” Weiss said. To foster that sense of belonging, the SA chapter sponsors a departmental barbecue at the end of each year where students can make friends, interact with faculty—and maybe find a new hobby by joining the chapter.

“If you give students a lot of volunteer
opportunities, I think that helps,” Anderton said. The senior said the “Cool Science” programs are particularly popular.

Ping Furlan (ACS ’98), chapter adviser at the University of Pittsburgh at Titusville, agrees that programming is very important in maintaining chapter momentum. Her students started their award-winning chapter six years ago and offer a variety of educational programs, including a chemistry study hall to aid students needing extra help and a chemistry “show-and-tell” at chapter meetings where members perform experiments for their peers.

“It increased the attendance at meetings, and they feel very proud about it after they’ve done them,” Furlan said.

Anderton also works to increase meeting attendance. He tries to schedule meetings so they don’t conflict with classes and noted, “It doesn’t hurt that we have food.”

He recommends that student leaders make their chapters visible on campus but warns that they shouldn’t get discouraged if a particular activity doesn’t draw a big crowd. “As a whole, I would say this chapter is very successful,” he said. “But on each individual event, we might get just 20 to 30 members helping out.”

Advisers, too, should try to stay positive despite setbacks, according to Texas Southern’s Willis. “Expect mountains, though you may get hills,” she said. “For a reactivated chapter, seeing a hill is an improvement versus seeing nothing at all.”

Rachel Smolkin is a freelance writer in Washington, DC, and a regular contributor to Chemistry. In addition to being our regular Student Affiliates columnist, she wrote recent Chemistry features on global outsourcing and other topics.
Bumped from a flight? Flight delayed or canceled? As frequent flyers, chemists and other scientists often encounter those hitches. Knowing about passenger rights can ease the pain and may help put cash or other compensation in your pocket.

Lisa Baugh (ACS ’90), a polymer chemist with ExxonMobil, has endured canceled flights, weather delays, and missed connections. During one stormy night, she slept on the floor at Atlanta’s Hartsfield-Jackson International Airport. “The severe weather forced me to miss a connection,” Baugh recalled. “An airline rep broke the sorry news that hotel rooms were booked. But at least she directed me to a safe part of the terminal where I could curl up.”

Winging their way to conferences and meetings, chemists and other scientists rank near the top of the frequent flier list, and absorb more than their share of air travel’s bumps.

U.S. Department of Transportation (DOT) data that report on-time performance for carriers show that 127,757 flights were canceled in 2004, up from 101,469 in 2003. The number of passengers involuntarily bumped from flights rose from 41,932 in 2003 to 44,900 last year. But complaints haven’t taken off, despite this upward trend.

“Passengers flying at historically low fares don’t tend to be as upset about delays and cancellations,” said David A. Stempler, president of the Air Travelers Association, an airline passenger advocacy group in Potomac, MD.

No Compensation Required
There’s a common misconception that airlines must compensate passengers whose flights are delayed or canceled. Not so. There are no federal requirements. Each airline has its own guidelines embedded in a section of its contract of carriage, often called “Rule 240,” that specifies passenger entitlements. DOT does require airlines to keep a copy of this passenger bill of rights at their ticket counters.

Some seasoned travelers never head for the airport without a copy of an airline’s Rule 240 or its counterpart. The documentation also can be found on most airline websites or requested by calling the carrier.

Hit with a cancellation or delay, most airlines will at least book passengers on the next available flight to their destination. But depending on circumstances and the carrier, a lot more could be forthcoming, such as meals, free phone calls, and hotel rooms.

For instance, Baugh got reimbursed for both a hotel and meals when she missed a late-night connection in Cleveland. On a trip to Houston, an airline paid for a rental car when she missed an important connecting flight to College Station, TX.

When in a bind, Baugh tries to be polite and work with airline employees rather than losing her temper. “You can let them know your concerns without becoming angry,” she noted.

The airlines usually have trouble-shooters at the airport who, depending on the circumstances, sometimes can ease the pain by coming up with some sort of reparation.

The “Bumped” Fare Better
Overbooking is an entirely different matter. Airlines are allowed to overbook flights to make up for no-shows. Almost every frequent flier has heard a plaintive gate attendant asking for volunteers to give up their seats and take a later flight in exchange for a reward such as a free round-trip ticket. Carriers have to make this appeal before leaving behind passengers with valid tickets and reservations.

But unlike the canceled and delayed, those who are involuntarily bumped from a flight can get cash for their inconvenience. They can receive up to $200 if they’ll be 1–2 hours late reaching their destination and as much as $400 if delayed more than 2 hours (4 hours internationally) on a substitute flight.

The “denied boarding” money is essentially payment for an inconvenience. The original ticket can be used on another flight or turned in for an “involuntary refund.”

People who don’t check in on time or buy a ticket at least 30 minutes before departure aren’t entitled to anything. Furthermore, payouts don’t have to be
made if the bumping involves a charter flight, a switch to a smaller aircraft, or a plane holding 60 or fewer passengers.

Once passengers accept a check, cash, or other compensation, they usually forfeit the right to demand more afterwards. But if the settlement offered doesn’t cover the personal cost of being bumped, it’s sometimes possible to negotiate a more generous outcome with the airline’s consumer relations department.

DOT provides the pertinent names, addresses, phone numbers, and Web addresses for the consumer relations departments of the 19 domestic carriers covered by its reports at: http://airconsumer.ost.dot.gov/publications/contacts.htm

The agency tells travelers to take several steps when an event occurs so they will have all the information when they write or call. DOT advises travelers to make notes at the time and jot down the names of airline employees involved. Keep all travel documents such as ticket receipts, baggage check stubs, and boarding passes, as well as receipts for out-of-pocket expenses that were incurred because of the incident.

**Complaints May Get Results**
A written letter following the DOT guidelines (please see sidebar) may get results. It’s in a carrier’s interest to find out what’s causing problems, take actions to prevent them, and keep customers happy.

“We want to be a carrier of choice, not convenience,” said David A. Castelveter, a US Airways spokesman. “So we try to assure that our customers have a good experience not only when they’re flying, but with any peripheral issues they might have.”

If calling or writing an airline doesn’t get results, consider lodging a formal complaint with DOT by calling the Aviation Consumer Protection Division at 202-366-2220. A written grievance can be sent to Aviation Consumer Protection Division, C-75, U.S. Department of Transportation, 400 Seventh St. S.W., Washington, DC 20590.

**Writing an Effective Complaint Letter**
The U.S. Department of Transportation offers these tips for writing an effective complaint letter to an airline:

- Type the letter and, if possible, limit it to one page.
- Include a daytime telephone number with area code.
- No matter how angry you might be, keep the letter businesslike and don’t exaggerate what happened. If the complaint sounds very vehement or sarcastic, it might be best to wait a day and then consider rewriting it.
- Describe what happened; give dates, cities, and flight numbers or flight times.
- Send copies, never originals, of tickets and receipts or other documents that can back up a claim.
- Include the names of employees who were rude or unhelpful, as well as anyone who might have been especially helpful.
- Don’t clutter the complaint with petty gripes that can obscure what you’re really angry about.
- Let the airline know if you’ve suffered any special inconveniences or monetary losses.
- State exactly how you expect the carrier to make amends. An airline may offer to settle a claim with a check or some other kind of compensation, possibly free transportation. However, you may only want an apology from a rude employee or a specific reimbursement for some loss you incurred.
- Be reasonable. If demands are way out of line, your letter might earn nothing more than a polite apology and a place in the airline’s crank files.

— DJ F
SAVING WISELY
for College

BY KERRY J. SCAFELLA

With college costs skyrocketing, financial planning now for your children or grandchildren is essential. As you map out an education savings strategy, pay special attention to important concepts like the quality of the program and its tax consequences.

Education funding is a hot topic these days. With the average cost of college soaring, families are coming to realize that they had better start saving sooner rather than later.

In the past three decades, public college tuition has increased steadily, while tuition and fees at private schools have skyrocketed— to the point where the price of a four-year education, plus room and board, at a moderately priced private school can top $100,000. With yearly increases at many schools far outpacing the rate of inflation, it's no surprise that parents, grandparents, and other guardians are seeking ways to help reach tuition goals. A College Savings Plan such as a 529 plan can help.

Save with High Limits
College Savings Plans can offer a particularly effective way for middle- and upper-income families to save for education because there are no restrictions on the amount of income contributors can have to fully fund the program. Limits on total contributions to a particular plan may vary, but most plans allow you to accumulate more than $200,000 in these tax-deferred accounts.

Plans adjust their contribution and accumulation limits annually. Any U.S. resident can invest, and withdrawals can be used at any eligible post-secondary school in the United States, including public and private colleges and universities, community colleges, and most vocational schools. The money saved helps pay for tuition, room and board on or off campus, books, and other required supplies.

Save with Flexibility
Put money away now, and on a regular basis, to pay for the college education of your children, grandchildren, siblings, nieces, and nephews—even close friends. It doesn't matter where you live or where the beneficiary attends college. You can even save for your own college expenses. Initial investments vary, but may be as little as $25.

The contributions in a College Savings Plan are usually invested in one or more predetermined structured portfolios. Typically, plans include an age-based or years-to-enrollment series of portfolios, static portfolios that do not alter their investment allocations over time, or individual fund portfolios that allow for a greater degree of customization.

Some of these portfolios may be offered in a choice of moderate, conservative, or balanced options. After selecting which portfolios will receive each contribution, the contributor has no direct say in how the portfolios are invested or managed.

For example, age-based portfolios will usually hold more equities while the beneficiary is young. As the beneficiary ages, funds are automatically moved into portfolios with a larger portion of fixed-income investments, thus reducing the risk of stock market volatility eroding funds needed to pay for college expenses in the near future. The performance of the portfolios depends on market conditions. Past performance is no guarantee of future results.

The account always remains under your control. You can change the beneficiary anytime, and there is no age restriction for the student. However, the possibility always exists that the beneficiary of the account may not go to college, or may receive a scholarship that covers all or part of college expenses. Several alternatives are available that can help you avoid penalties for non-qualified use of funds.

College Savings Plans offer you the flexibility to make a tax-free transfer of the account to a sibling or another family member who can then use the funds for qualified education expenses. In the case of scholarships, taxable but penalty-free withdrawals of funds up to the scholarship amount are allowed.

Taxes, Taxes, Taxes
By saving for education expenses through College Savings Plans, you may be able to benefit from the many tax advantages that
Attention Grandparents

There is no greater tax-free gift for your grandchildren than the money they’ll need for college. Help them, and at the same time effectively lower the taxable value of your estate.

An individual may contribute up to $55,000 and married couples may invest up to $110,000 in a single year and have the contributions treated as five gifts of $11,000 or $22,000, spread over five years—without incurring gift taxes. This assumes the same donors make no additional gifts to the same beneficiary during the five-year period.

The IRS deems these dollars to be a completed gift, and out of the donor’s estate unless the account owner dies within five years of the gift. If that should happen, a prorated portion of the original contribution amount only will be included in the donor’s taxable estate.

— KJS

529 Savings Plans

More and more companies are offering payroll deductions for 529 savings plans. This makes it even more convenient to save systematically for college.

If you are considering a 529 Savings Plan, you’ll be glad to know that Coverdell Education Savings Account (ESA, formerly known as an Education IRA) contributions or distributions are permitted even if you contribute to or withdraw from a Section 529 College Savings Plan in the same year.

For married taxpayers, filing a joint tax return and with an adjusted gross income (AGI) up to $190,000, the maximum annual ESA contribution is $2000 per child under the age of 18. The ability to contribute phases out for salaries between $190,000 and $220,000.

Anyone who meets the AGI restrictions can contribute to an ESA that is set up for a child under the age of 18 (the restriction is waived if the child is a special needs
beneficiary). A contributor does not have to have earned income to make a contribution, as is required with an IRA.

And there’s another plus. In addition to college or graduate school, you can use these funds to cover elementary through secondary school expenses as well. So, the ESA could be a smart investment vehicle if you plan to send your children to private grade school or high school. All earnings will be exempt from federal, state, and local tax as long as the account is used to pay for qualified expenses. Even if you send your children to a public grade school, you can still use an ESA to save for certain out-of-pocket expenses.

The new tax law allows you to use your tax-free distributions to purchase the following: computer equipment, uniforms, transportation, extended-day programs, academic tutoring, books, and supplies, in addition to tuition and room and board at public, private, or religious schools. Unlike 529 plans, ESAs have no “sunset” provision on the tax-free withdrawals.

You may also claim a HOPE Scholarship or Lifetime Learning credit in the same year as an ESA or Section 529 College Savings Plan distribution, as long as you claim different expenses.

**Traditional Versus Roth IRAs**

You can withdraw funds early from a traditional IRA to pay higher education expenses without paying the 10% penalty. The downside is that you will still be liable for any regular income taxes due on the amount withdrawn. So, the Education Savings Account is a better choice.

The benefit of a Roth IRA is that, if it has been established and funded for five years or more, it allows you to withdraw your earnings for educational purposes before the age of 59½, penalty-free. Again, any earnings you take out will be subject to regular income tax.

**Begin Saving Now**

With no end in sight to the soaring cost of college, getting started in any education savings plan is a step in the right direction. But, before you make any decision as to how you will finance your children’s, grandchildren’s, or other relatives’ education, speak with your tax and financial advisers. They have information and experience that could help you plan for this important event.

A Financial Consultant can provide more information and help you determine which plan may be suited to your needs. Kerry J. Scafella is a Financial Consultant with Smith Barney in Washington, DC. Smith Barney does not provide tax or legal advice. Please consult your own tax and/or legal adviser for such guidance.
The 100th anniversary of Albert Einstein’s “miracle year” is a celebration of chemistry as well as physics. In 1905, Einstein published a series of papers that profoundly transformed physics and forever changed the way chemists investigate, exploit, and think about matter. They assured that an obscure Swiss patent clerk would become perhaps the greatest scientific and cultural icon of the 20th century.

Einstein called 1905 the year “a storm broke loose in my mind.” The thunder and lightning were papers on Brownian motion, the photoelectric effect, relativity, and the famous mass–energy relationship that may be the world’s best-known mathematical equation, $E = mc^2$. With the end of the 19th century, many scientists believed that most of the fundamental laws of physics had been established, thanks to the genius of Newton and those who expanded his work. All that remained, they thought, was a little more tweaking to improve accuracy. Einstein shattered that illusion with his stunning and unexpected outpouring of ideas.

“Through Einstein, you go from the world of the machine—the very mechanical idea that you can predict everything with Newtonian mechanics—to the probabilistic world of Heisenberg’s uncertainty principle and the idea that you can only know the outcome of an experiment to a certain degree of accuracy,” said Michelle Francl (ACS ’75), professor of chemistry at Bryn Mawr College.

From Photochemistry to Nuclear Chemistry

Einstein, then 26, submitted his paper on the photoelectric effect to Annalen der Physik, Germany’s leading physics journal, in March 1905. Nobody dreamed it would win him the Nobel Prize in Physics 16 years later.
later. Einstein proposed that light acts like discrete, independent particles of energy. His theory went beyond the ideas of Max Planck and contradicted the popular notion that light consisted of smooth, oscillating electromagnetic waves.

Light quanta, Einstein argued, could explain many phenomena, and he showed how light ejects electrons from metals, an achievement that eventually led to photo-electron spectroscopy. “It was Einstein’s publication of the photoelectric effect that led to almost everything we do in the quantitative photosciences today,” said Douglas C. Neckers (ACS ’59), executive director of the Center for Photochemical Sciences at Bowling Green State University.

Photochemistry and related endeavors are now the basis for multi-billion-dollar industries with products ranging from photographic film and photocopy machines to computer chips (carved out of silicon with photolithography) and organic light emitting diode (OLED) displays.

If the photoelectric effect paper got Einstein to first base in the genius game, three others took him to home plate. In May 1905, he explained Brownian motion in detail and suggested a way to test the theory that heat results from the ceaseless motion of atoms. This insight gave chemistry a new tool for studying the movement of atoms.

“His explanation mapped precisely onto the experimental observations that Robert Brown had made earlier,” noted Cecil Dybowski (ACS ’76), professor of chemistry at the University of Delaware.

June saw the debut of Einstein’s Special Theory of Relativity. Based on his innovative analysis of space and time, he related electromagnetism and motion. “Only in the last 10 or 20 years has the importance of relativistic effects to chemistry become appreciated,” said Nobel laureate Roald Hoffmann (ACS ’63), the Frank H. T. Rhodes Professor of Humane Letters at Cornell University. “Various aspects of the chemistry of gold, for example, are a consequence of relativity at work.”

In September, Einstein reported a remarkable consequence of special relativity. A body emitting energy loses a proportional amount of mass, or $E=mc^2$, energy equals mass times the speed of light squared. “There would likely be no nuclear chemistry if it weren’t for Einstein,” Neckers observed.

For a century, the principles Einstein laid out in his 1905 papers have influenced chemistry, although indirectly. “We don’t think of Einstein as being related to chemistry but, in fact, he is,” said Dybowski. “He provided the underpinnings of several important technologies that we use today, but that is something we take for granted.”

Quantum Yield

Light in 1905 remained a dimly understood phenomenon. Max Planck had published his classic paper on light and quantization five years earlier. It tackled the blackbody radiation problem by suggesting that the little oscillators in all matter emit light only in certain distinct bits of energy. Basically, Planck argued that the energy of a light beam depended on its wavelength. But a good explanation for energy quantization defied the great German physicist. He suggested an explanation, but dismissed it as a numerical trick. “Planck didn’t really
believe in quanta, and neither did the scientific community at large until Einstein’s photoelectric effect explanation,” Hoffmann said.

Einstein used Planck’s concept to re-examine blackbody radiation and provided the clinching answer to the puzzling effect known as the “photoelectric effect” that Heinrich Hertz had discovered in 1886. The mystery: Ultraviolet light can force electrons to eject from a metal surface. Einstein accepted Planck’s idea of oscillators, which he called “quanta” (now known as photons) and related the wavelength of a quantum to its energy. Then, he showed quantitatively that the threshold for ejection of electrons depended on the wavelength of light, not on its intensity.

What Einstein saw, and in some sense what Planck did not see, was that Planck’s solution was not just a numerical trick, but a far more fundamental concept—“that energy came in discrete packets and you could exchange energy between light and electrons and atoms,” said Franci.

Einstein’s theories that led to the photon underlie the concept of the quantum yield, the proportional relationship of the molecules that absorb light to those that react by means of a specific molecular process. “There was huge experimental attention paid almost immediately to the phenomena that came first out of the 1905 paper and later from a paper he published in 1912,” Neckers explained. “This culminated with a much later decision to define the unit called an ‘Einstein’ as one Avogadro’s number of photons, 6 x 10^23.”

From Einstein’s insights into the nature of light, other scientists engineered new disciplines, nature-eliciting concepts, and devices invaluable to chemists and humanity in general. The list includes photochemistry, photoelectron spectroscopy, lasers, photonics, and, of course, quantum mechanics. “Bohr’s theory of the atom in 1913 needed the certainty that energy was quantized, which Einstein provided,” Hoffmann said. “Indirectly, that 1905 paper is fundamental in establishing the validity of quantum mechanics, which went on to become important to chemists. If I were to single out which of the four papers had the most direct effect on chemistry, it is that on the photoelectric effect.”

Einstein himself never accepted quantum mechanics, and his disbelief in its apparent absolute randomness led to his famous statement, “God does not play dice with the universe.” Yet quantum mechanics has benefited chemistry for decades. In 1928, for example, Linus Pauling startled chemists when he announced he could use quantum mechanics to explain why a carbon atom with four bonds forms tetrahedral bonds.

Photoelectron Spectroscopy

Perhaps Einstein’s single greatest contribution to chemistry emerged from his first 1905 paper. The photoelectric effect underpins photoelectron spectroscopy, which in its various forms is a mainstay that chemists use to measure systems. “Photochemistry and spectroscopy are intertwined irrevocably, and the history of chemistry itself winds through spectroscopy and photochemistry,” Neckers said. It was at this interface that the nature of the chemical bond was discovered, he added.

“In surface chemistry, photoelectron spectroscopy tells you about the chemical states of materials right at the surface of, say, a catalyst or a material that has some coating on it,” said Dybowski. “If you knock electrons out of different orbitals, you can basically measure the kinetic energy, or binding energy, and that indicates from which orbital an electron came. Then you can say you have carbon on the surface, for example. And it is all due to Einstein’s photoelectric effect.”

Photoelectron spectroscopy relies on the principal of one photon in and one electron out. Chemists predominantly use two forms of the technology to study surfaces, X-ray photoelectron spectroscopy (XPS) and ultraviolet photoelectron spectroscopy (UPS).

During XPS, the absorption of a photon by a molecule or solid results in ionization and the emission of a core electron. Each element has a specific binding energy and yields a characteristic set of peaks in the photoelectron spectrum, which serves to identify its presence in the sample. XPS uses electrons diffracted by neighboring atoms to gain information about the structure of a surface crystal.

In UPS, a photon’s interaction with a valence level electron results in ionization and the removal of one valence electron. The advantage of UPS over XPS lies in its narrower linewidth of radiation and its high flux of photons from simple radiation sources. UPS has proven particularly effective in studying the electronic structure of solids and the absorption of relatively simple molecules on metals.

The availability of synchrotron radiation...
facilities has provided chemists with a wider and higher energy range and enabled them to use photoelectron spectroscopy to probe the nature of matter at higher resolutions. The data obtained in such studies of surfaces, thin films, and interfaces have given a clearer picture of their electronic, geometric, and magnetic properties.

“I calculate the orbitals of molecules, not just the higher energy ones but others, too,” said Hoffmann, who shared the 1981 Nobel Prize in Chemistry for his theoretical work explaining how properties of frontier orbitals could explain certain reaction courses. “Photoelectron spectroscopy has provided me with experimental proof of the ways orbitals interact.”

Theoretical and Computational Chemistry

A century ago, theoretical chemists focused on macroscopic issues such as the mechanisms of electrochemistry, reaction chemistry, and thermodynamics. The mathematics? For the most part, theoreticians left math to the physicists. Thermodynamics was an exception, having attracted pioneers in both disciplines, including physical chemist Josiah Willard Gibbs of Yale.

Today, theorists explore the microcosm of chemistry, such as the mechanisms of photochemistry and the energy conditions and forces that drive chemical reactions and phase changes on the molecular level. Their tools include quantum mechanics and Schrödinger equations—both stepchildren of Einstein’s paper on the photoelectric effect.

Many regard modern theoretical chemistry as the equivalent of quantum chemistry, but theorists also use the average properties of molecules, or statistical mechanics. “Einstein built the foundations of modern statistical thermodynamics,” Hoffmann said. “He used statistical ideas very cleverly.”

High-speed computers have enabled chemists to decipher previously unsolvable problems. “Quantum chemistry helps us understand what holds a molecule together, how it will change into another molecule, and how reactivity works,” said Frond. “It is easy to write these equations down. It is impossible to solve them without the computer.”

Computational science provides a third approach, whether applied to chemistry, biology, or physics. It goes beyond the traditional duo of experimentation and theory—by using computers to perform extraordinarily difficult calculations and simulations. In recent years, it has penetrated almost every branch of chemistry.

“Computational chemistry really deals with trying to understand what molecules and matter look like, what their structures are, and how they behave,” said Frond. “Some people jokingly called it in silico chemistry, as opposed to in vitro and in vivo. Basically, it is any chemistry that uses computer-modeling methodology to solve chemical problems.”

The history of computational chemistry tracks that of the computer—as well as advances in algorithms, numerical methods, and approximations used by computational scientists. However, it came into its own in the 1980s, when experimentalists began seeking the aid of their computational colleagues in understanding their results. Yet computational chemistry also traces its roots to Einstein. “The photoelectric effect paper, in some sense, founded computational chemistry,” said Frond, immediate past chair of ACS’s Division of Computers in Chemistry. “That one paper turned the key for everything from the laser to quantum chemistry.”

For a time, computational chemistry all but equated with quantum chemistry. Finally, computing power reached the point where it could solve some of the complex equations of quantum mechanics that had long stymied scientists. Today, computational chemists address a variety of problems using other techniques, such as molecular mechanics and molecular dynamics, to solve problems relating to an entire molecule, an important advance for the development of new drugs and the design of new and better catalysts.

“The object of all these computational exercises is ultimately to know so much about a molecule that, without doing the experiments, you can predict its qualities,” Dybowski said.
Brownian Motion

In 1828, the English botanist Robert Brown reported that pollen grains suspended in still water moved incessantly in a swarming motion. The phenomenon became known as Brownian motion and long perplexed scientists searching for an explanation. Einstein solved the mystery in his second 1905 paper. By applying the kinetic-molecular theory of heat to liquids, he predicted that the random motion of molecules in a liquid would impart an irregular random motion to tiny particles suspended in it.

Einstein's paper helped resolve a classic controversy in the history of chemistry, the one over whether it was possible to prove the existence of atoms and molecules. Leading one side was Friedrich Wilhelm Ostwald, the charismatic German chemist often called the Father of Physical Chemistry, who was awarded the 1909 Nobel Prize in Chemistry for his work on catalysis, chemical equilibrium, and reaction velocities. Leading the opposition was Austrian physicist Ludwig Boltzmann (an early pioneer in quantum mechanics). Ostwald's camp said, “No.” Boltzmann and his supporters took the view that molecules and atoms not only existed; they could also explain almost all the properties of matter.

The Brownian motion paper injected a new element into the dispute. It provided the Boltzmann group with both a theory and the visual evidence to press their argument that one could conclusively demonstrate the existence of molecules, at the very least. Einstein went on to explore the issue in 1908 in another paper on Brownian motion.

Jean Perrin, a physical chemist at the Sorbonne in Paris, began a series of experiments that same year using a Brownian solution containing minute particles as nearly identical in size as possible. The findings of Perrin and his students proved the existence of atoms and validated the kinetic-theory approach that Einstein used in his first Brownian paper.

“By 1910, basically the whole chemical community agreed that molecules existed,” Dybowski said. Even Ostwald yielded and accepted the existence of atoms.

Beyond its importance to theory, Brownian motion has had a very practical impact on chemistry. It has, for example, made a significant contribution to the understanding of aerosol particles.

“Einstein solved the problem of little spheres that were exactly the same size moving in a uniform liquid,” Dybowski said. “It turns out that the model is also the basis for talking about globular polymers. Polymers are not regular little balls, but polymer chemists have a concept called the radius of gyration. Because of some measurements that you can make of diffusion and light scattering, you can use Einstein’s theory to estimate the size of globular polymers.”

The Chemistry of Special Relativity

Einstein’s paper on special relativity contained a startling concept that boggled the greatest scientific minds of the era: Time is not absolute, but depends on your location in the universe and the speed at which you are traveling. Thus, observations of time and length made by two observers moving relative to one another differ, and relativistic effects on fast-moving objects can affect them in ways Newton never imagined.

Remember the paradox of the twins? One twin leaves on a space journey at the speed of light and returns 30 years later—not a day older, while the Earth-bound sibling is ready for retirement.

At first, this interpretation of relativity seemed of little use to chemists. Indeed, Paul Dirac insisted in 1929 that relativistic effects have “no importance in the consideration of atomic and molecular structure and ordinary chemical reactions.” And that largely settled the matter until 1979, when new research described the need for special relativity in understanding the chemistry of heavy elements.

Relativistic effects assume significance in some transition elements and heavy elements because electrons orbiting close to a heavy
nucleus travel so rapidly. Einstein’s theory correlates the mass of a particle with its velocity, and thus the speed of these electrons increases their mass and lowers their orbit, which affects their interaction with the nucleus.

“If you calculate their velocities, they are moving at appreciable fractions of the speed of light,” Dybowski said. “So they have now become relativistic particles and in order to do calculations that are correct, you have to account for the relativistic properties of those electrons.”

Dybowski uses nuclear magnetic resonance (NMR) to measure the chemical shielding of heavy atoms, which depends on an element’s electrons and causes a shift in the NMR spectral lines. Every nucleus has a variety of chemical shieldings, which a chemist can often predict theoretically from the quantum mechanical wave functions of its electrons.

“If I try to do that for heavy atoms with nonrelativistic computer programs, I get nonsense,” Dybowski said. “It is only because we include the fact that these are relativistic

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**BETTING ON A SURE THING**

In 1903, Einstein married Mileva Maric, a physics student, and they had two sons, born in 1904 and 1910. In 1912, Einstein began an affair with his cousin, Elsa Löwenthal, and in 1914, he and Maric separated. Five years later, the two divorced and Einstein married Löwenthal.

In the 1919 divorce settlement, Einstein agreed to give Maric the money from his Nobel Prize in Physics. Maric obviously had faith in her former spouse’s science, for Einstein had not yet won the prize.

The honor came in 1921, and the entire $32,000 purse went to Einstein’s former wife.

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**MASS–ENERGY EQUIVALENCE**

One of only three existing Einstein manuscripts that contain the famous E=mc² equation. It describes the relationship between energy (E), mass (m), and the speed of light (c), derived from the Special Theory of Relativity. The theory states that time and space are relative, and depend on an observer’s state of motion relative to other observers.
particles that we can get close agreement with experimental results. So special relativity is entering into chemistry in a way that it has not done in the past," Dybowski said.

**Einstein’s Legacy**

Einstein made sweeping contributions to chemistry that propelled it forward as a science. Yet his most important chemistry has been overshadowed by the glitzy material in his last two papers. “The photoelectric effect and Brownian motion have gotten buried in all the history because of special relativity, E=mc\(^2\), and the atomic bomb,” Neckers said.

Nevertheless, during the past century, chemists have translated some of Einstein’s most fundamental insights into tools that have moved the science very far forward, both in understanding matter and its interactions, and in converting that knowledge to commercial products. “We have people, like Einstein, who think about issues, and those who think about what they can do with theory, and we need both,” Dybowski said.

Francl attributed more to Einstein than his revolutionary ideas and their influence on the physical sciences. “In the year he published those four papers, he did so in three completely different fields of physics,” she noted. “When you cross fields, really magical things happen sometimes, and Einstein showed that is really true. I think his legacy is also one of excitement; it certainly is with my students.”

Patrick Young is a freelance science writer in Laurel, MD. His awards include the ACS James T. Grady Award for Interpreting Chemistry to the Public and the American Institute of Physics Science Writing Award in Physics and Astronomy.

**Chemical Element Namesake**

The codiscoverers of element No. 99 paid tribute to Albert Einstein by naming it Einsteinium (Es). They gathered at the Lawrence Berkeley Lab for a symposium marking its 25th anniversary. Left to right (front row): Louise Smith, Sherman Fried, and Gary Higgins. Left to right (back row): Albert Ghiorso, Rod Spence, Glenn T. Seaborg, Paul Fields, and John Huizenga (ACS ’45).

**Computed Structures**

Structures like [20]moebiusene, a “one-sided” molecule, emerged from Einstein’s genius. Researchers are studying the moebiusenes as potential “chiral containers” and for their aesthetic appeal. The molecules are strained in one spot when the strain looks like it should be spread out all over the molecule.
Chemists and chemical engineers from academe may account for the majority of individuals who work as consultants. However, consulting is a full-time job for thousands of chemists, and a dream of many others. What are the secrets for success?

By Anne Kuhlmann Taylor

Mention consulting to a group of chemists or chemical engineers, and you’ll conjure thoughts of professors who occasionally step out of the lecture hall and use their expertise to help industry solve research and development problems. That stereotype of the chemical consultant as an academic type working at it part-time is quite accurate. About 52% of chemists who consult hold a primary job in academia, according to American Chemical Society (ACS) Comprehensive Salary and Employment Status surveys.

However, consulting is the one and only “real job” for a hefty number of chemists and chemical engineers. About 2% of ACS members report that they are full-time consultants, according to Mary Jordan (ACS ’97), workforce specialist in the ACS Office of Employment Information. About 10% of survey respondents report some income from consulting. Most work in the non-manufacturing sector or are self-employed. Many more are part-timers who are retired and use consulting to supplement their income and keep in touch with chemistry.

How do chemists begin a career in consulting? What are the keys to finding clients? Where do consultants work? How much money do they earn? What are the rewards, and the pitfalls, of the work that often beckons when chemists dream of being their own boss? To get answers to these and other key questions, Chemistry went to the real-world experts—individuals who have been successful with a primary job in full-time or part-time consulting. Although the individuals and their services are different, they all share attributes that may be among the keys to a successful consultancy.
Plastics, Detergents, and Grants

Peter Lantos (ACS ’45) has been a consultant since 1980, with a specialty in plastics technology and marketing—including additives for plastics and machines for plastics manufacturing. When one company developed a new polymer, they hired Lantos to determine whether there was a sufficient market for the product. He also helped them develop its marketing and pricing strategy. Lantos’ company, The Target Group, has only two employees, Lantos and his wife, Sandy. But he has assembled about 20 other consultants who work on a subcontractual basis. “I have found that two people are better than one on most projects,” Lantos said, because adding a second consultant creates greater depth and a more diverse perspective.

Ruth Hathaway (ACS ’82) is proof that you don’t have to have a Ph.D. to become a successful consultant. She has a B.S. degree in chemistry and has done some graduate work. With extensive experience in hazardous waste and environmental chemistry, she founded Hathaway Consulting LLC. The environmental consulting firm works with electroplaters to solve problems involving U.S. Environmental Protection Agency regulations. “We help them determine if they are out of compliance or just have a sampling problem,” Hathaway explained. She worked alone at first, but business mushroomed to the point where Hathaway Consulting established eight offices around the country, each staffed by two people.

Chemical engineer David deLesdernier began in engineering consulting but transitioned into government contracts. “I can help people land government contracts and help them manage the contracts,” he said. “I found that this was a marketable skill.” deLesdernier has a two-person firm, derier technologies, inc., which he shares with his wife, Mary E. deLesdernier, a computer and database consultant.

Daniel M. Goldman (ACS ’95) uses consulting to supplement his employment as a pharmaceutical chemist and to fill the time between jobs. “Since no job is secure in today’s world, why can’t you have more than one business?” Goldman does technical writing, including grant writing and pharmaceutical documentation, in a one-person firm, Supreme Business Services. Clients range from a science museum to a publishing firm that specializes in producing chemical catalogs for fine chemical intermediates.

When Rita Boggs (ACS ’67) started American Research and Testing, Inc., 22 years ago, it was really her third career. In her first career, she was a Catholic nun who taught chemistry and physics to high school and college students. She went back to school for a Ph.D. in chemistry, began a second career as an industrial chemist, and moved into management. Finally, she started her own contract laboratory. The three-person company now specializes in consulting. “People come to us with problems, and our job is to translate the problem into a research project and find a solution,” said Boggs. One client, the California Prison Industries Authority, made detergents and sold them to other prisons and state agencies. American Research and Testing reformulated the products to be more environmentally friendly.

Getting Help from ACS

Both beginning and established consultants need contact with other consultants and sources of information about finances, marketing, and other essentials. ACS can help through Career Services, the Division of Small Chemical Businesses (SCHB), and the ACS Member Insurance Program.

The ACS Department of Career Services offers access to 54 volunteer Career Consultants who mentor chemists going through career changes, including the transition to consulting. In addition, Career Services holds a series of workshops that are presented at each National Meeting.

SCHB program chair Peter Bonk (ACS ’76) explains that because a number of SCHB members are consultants, the division presents programming for them at the National Meetings.

The Division of Small Chemical Businesses subsidizes the cost of a booth at the National Meeting Exhibition. Four SCHB members are invited to publicize their businesses to attendees. In Philadelphia, deLesdernier was an exhibitor promoting the Chemical Consultants Network. In addition, the division sponsors a reception at each National Meeting, which offers a great opportunity for members to network.

The ACS Member Insurance Program offers an excellent variety of plans. Self-employed consultants need all types of insurance—life, health, disability, etc.—and the ACS program offers reasonably priced policies. One product that is hard to get elsewhere is Professional Liability Insurance for Chemical Professionals in Consulting.

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Getting Started and Finding a Niche

Like these individuals, consultants usually have a specialty area—a niche—which is their marketable skill. When Joseph V.
Porcelli (ACS ‘82) retired with 40 years of management experience in industry, he hoped to help higher-level executives with their own management problems. “I looked for general management consulting in the chemical industry,” Porcelli recalled. “It didn’t work!” A mentoring conversation with Peter Lantos reoriented Porcelli. He recalled Lantos’ words: “People hire expertise, not management.” Porcelli discovered that his knowledge of catalysis and petrochemical processes was marketable. He now helps companies move those new technologies from the lab to the marketplace. Early work reviewing project proposals for the U.S. Department of Energy also led to larger DOE assignments.

When William H. “Bill” Suits (ACS ‘64) retired after 40 years selling chromatography equipment, he knew his niche. He picked a company name, Chromatography Connections, to emphasize an ability to bring buyers and sellers together. “Upon retirement, I had two vendors signed up who needed my support,” Suits recalled. After two quite active years selling equipment, Suits has reduced his workload but still consults.

Darrel Bryant (ACS ‘98) described his niche as “rheology control in adhesives, sealants, coatings, and anything where you need to control the consistency.” For example, toothpaste needs a dash of calcium carbonate or silica so it won’t flow off the brush. “I always wanted to develop my own business in the chemical industry,” Bryant said. “When I was laid off, everyone in my family thought I should go into business for myself.” It took about two months to develop the concept for his company, Material Apps, LLC. Now he helps clients choose the best materials, processes, and equipment for their formulations.

While many consultants start business after retirement, Lisa Balbes (ACS ‘85) started at a much earlier stage in her career. “I relocated for a job that didn’t exist by the time I arrived,” Balbes said. She landed one technical writing project and then another. “After three years, I found I had fallen into a new career,” Balbes explained. She now handles a variety of scientific writing projects, such as preparing journal articles and research reports, software documentation, marketing literature, and grant applications. One recent project involved writing instructions for surgeons using a new medical device.

With 30 years’ experience in battery technology, Kathryn R. Bullock became a consultant on power sources such as batteries, fuel cells, and capacitors. “The applications include many different industries—telecom, computer backups, nuclear plants, and consumer batteries,” she said. One client, for instance, needed help with a system for battery monitoring and finding people to buy the technology. Her one-person firm is appropriately named Coolohm, Inc.

After working for DuPont for 29 years, Don Bly (ACS ‘59) heard the words that started his consultancy career: “We’re thinning out managers.” He had the option of staying in a different position or leaving with an incentive package. At age 54, Bly left and stepped into a niche that existed because he was the author of a respected book on size exclusion chromatography. Returning from vacation one day, he found a message from a law firm, which had a case involving the technology. The firm hired Bly to tutor its lawyers about chromatography and advise on the case, a project that launched Bly’s new career as a consultant on the molecular characterization of polymers.

Office at Home or Away?

Many consultants work at home. They find it convenient and much cheaper than renting an office. In order to deduct home office expenses on your taxes, the room must be used only as an office. Porcelli recommends having a separate phone line for the business. Suits began business in a basement office outfitted with a computer, copier, and other basics. Balbes started her business with young children in the house, and they have grown up with Mom working at home. “Sometimes I would not answer the phone when the kids were screaming,” Balbes remembered. She finds
Handling the Finances

When a scientist becomes a consultant, he or she also suddenly becomes the owner of a small business, with full responsibility for all its financial aspects as well as its scientific side. Most consultants visit a lawyer and an accountant before they start. Some people learn to handle their finances on the job. Bullock took a course in business ownership at the Women's Opportunity Resource Center in Philadelphia. Like many consultants, she keeps her own records with small-business software but sometimes consults a lawyer or accountant.

A consultancy needs a financial structure. The first decision is whether to incorporate. Porcelli explained the possibilities in a talk at the 2004 Philadelphia ACS National Meeting:

- **Sole proprietorship.** A person working alone does not have to incorporate. The sole proprietor owns all the assets of the business as well as its profits. Reporting the income on his or her own tax return (Schedule C), the individual pays a self-employment tax. This is the simplest structure to set up, but it carries the disadvantage that the individual has unlimited liability.

- **Partnership.** Two or more people can share ownership of a single business. As in a sole proprietorship, the partners assume full liability for the business and the profits flow through to their personal tax returns.

- **C Corporation.** In this traditional “stock exchange” corporation, the owners have limited personal liability but may have to pay taxes on the profits both as a business and as an individual.

- **Subchapter S Corporation.** An “S” corporation is a simpler structure for a small business, which differs from a C corporation in the way its taxes are paid. The earnings and profits of the corporation are treated as distributions and pass directly to the owners’ personal tax returns. The owners have limited personal liability for the business.

- **Limited Liability Company.** This hybrid business structure is available in most states. Like a corporation, the LLC offers limited liability; as in a partnership, the profits or losses pass through to the owners’ tax returns.

Consultants Need Clients

In order to make money, of course, you have to find clients, and that can be difficult. “The secret,” said Peter Lantos, “is marketing, marketing, marketing.” He recommended that consultants network, speak to groups, write articles, and use websites to find work.

Other consultants heartily agree. Balbes, for example, met the head of a government agency when she was chair of her ACS Local Section. He later hired her to turn four research reports into publishable journal articles. “It may be five years between the time you first meet someone and when they actually have a project for which they want to hire you,” Balbes said.

ACS national and regional meetings are hotspots for networking and making contacts. “I am constantly networking at meetings,” Suits said. “I come home with 50 business cards.” About his committee service, Bryant said, “It is a way to market yourself—networking at the conference and volunteering for a committee.”

In order to get an assignment, consultants must find the right person within the client company. Goldman tackles that topic in a presentation and article appropriately entitled, “How to Hunt Down the Decision Maker against All Obstacles.” A consultant, for instance, may need to reach the vice president of regulatory affairs. “I ask him or her to give me one minute and then present my infomercial,” Goldman said. Even a “no thanks” can be beneficial. Before leaving, ask: “Can you suggest someone else who could use our services?”

Finding Work and Making Money

Some consultants do make big bucks, in the six-figure range. Fees, however, vary widely. Lantos gave the following guidelines for what consultants currently charge:

- **Novice consultant:** $500 per day.
- **Experienced consultant:** $1,200–$2,000 per day.

- **Specialized consultant in a hot field:** $2,500 per day or more.

Like many consultants, Lantos prefers setting fees by the project. Some charge by the hour. Boggs’ company gets $295 per hour. “Low-end” consultants may be paid the “professional contract labor rate” of $40–70 per hour, deLesdernier said. Technical writers may charge by the word, ranging from 50 cents to $2.00 or more.

that while working at home can be difficult, it has advantages: “I love the lack of commute and being home when the kids are home.”

Some types of consulting, of course, cannot be done at home. When Boggs started American Research and Testing, she bought equipment and set up a laboratory. Although Hathaway does not have a lab, she started with a home office and moved to a storefront as the business grew. She now rents space from an environmental engineer. Bryant is outgrowing his home office. “I need a storefront as the business grew. She now started with a home office and moved to a

LISA BALBES (ACS '85)

A consultancy needs a financial structure.

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Do You Need a Website?

When Rita Boggs started her consulting business in 1982, she bought a mailing list of 10,000 businesses. She selected potential clients and sent out 2,000 letters per month. “Then, all our marketing was by mail,” she recalled. “Now we have the Internet, which extends our market dramatically. We get inquiries from all over.”

Many consultants have a presence on the Web. Some have their own websites. Others participate in consultant groups which allow their members to have a page on the group’s website. The effectiveness varies. While Boggs gets many contacts through her website, Lantos does not. Balbes’ website works like an online brochure. “People check it and then call,” she said.

Joys and Worries

Despite the heavy responsibilities, consultants usually enjoy their work. “I love the independence,” said Boggs. “I have no regrets.” Porcelli finds it difficult to work alone. “I miss going to the office. I enjoy interacting with people. However, I really like the freedom.” Bullock finds the marketing difficult, but “I enjoy the work itself. It’s nice to plan your own schedule.”

Balbes pointed out that consulting itself—inherently enjoyable—is only part of the job, which requires a constant search for clients and often involves gaps with no income. Her overall experience, however, is positive. “I like having new projects. I am always learning.” Lantos summed up his experiences: “The downside is the risk and uncertainty, but I enjoy consulting tremendously. I enjoy the variety, the responsibility, and helping with some really important projects.”

Anne Kuhlmann Taylor, Ph.D. (ACS ’67), is a consultant and technical writer based in Baton Rouge, LA. Previously, she was an analytical chemist in the pharmaceutical industry. In addition to writing for chemistry magazines, she writes, edits, and critiques documents for the pharmaceutical and related industries. She is also the new Councilor for the ACS Baton Rouge Section.

Hot Websites

• ACS Career Services: chemistry.org/portal/a/c/s/1/career.html?DOC=careers%5Cindex.html
• ACS Division of Small Chemical Businesses: http://membership.acs.org/S/SCHB
• ACS Member Insurance Program: chemistry.org/portal/a/c/s/1/insurance.html?DOC=insurance%5Cindex.html
• Chemical Consultants Network: www.chemconsultants.org
• Association of Consulting Chemists and Chemical Engineers: www.chemconsult.org
• Mid-Atlantic Consultants (for consultants in all fields): www.maconsultants.com
• Institute of Management Consultants USA: www.imcusa.org
• Society for Technical Communication: www.stc.org
• Small Business Administration: www.sba.gov
• National Federation of Independent Businesses: www.nfib.com
• Legal information in everyday English—NoLo Press: www.nolo.com

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RITA BOGGS (ACS ‘67)

CHEMICAL CONSULTANTS MEET
David L. deLesdernier, Janice Bell, and David Gange (ACS ’77) represented the Chemical Consultants Network in the Small Chemical Businesses booth at the ACS National Meeting in Philadelphia.
Sir Alexander Fleming ended his Nobel Prize lecture 60 years ago last December with a warning about penicillin, the antibiotic he discovered in 1929. Penicillin, he said, might eventually lose effectiveness as bacteria mutate and develop resistance to the drug. People in 1945 thought the old fellow was losing it. Penicillin was the original “wonder drug,” saving thousands of lives among troops in World War II and curing infections in civilians that once proved almost 100% fatal.

By 1952, however, up to 60% of all Staphylococcus aureus (S. aureus) infections were penicillin resistant. Today, 70% of all bacteria that cause hospital infections are resistant to at least one of scores of antibiotics that have joined penicillin over the years, according to the U.S. Centers for Disease Control and Prevention (CDC). And “superbugs,” microbes resistant to multiple antibiotics, are claiming a terrible toll. About 2 million people get hospital infections every year. About 90,000 die as a result, and the health-care costs run into the billions of dollars.

The cause of death in these cases may be hidden, attributed to complications following surgery or other factors. “Nine times out of ten we’re talking about a bacterial infection,” said Steven J. Projan, vice president of protein technologies for Wyeth-Ayerst Research. “I don’t think the public realizes how often you can walk into a hospital healthy and be rolled out dead.” Resistance has spread to encompass “antibiotics of last resort,” powerful drugs like methicillin and vancomycin that are used when other antibiotics fail. No hospital in the United States reported a case of vancomycin-resistant enterococci bacteria before 1989. Found in the feces, enterococci are the most antibiotic-resistant bacteria in humans. Now, however, about 30% of hospital strains of enterococci are vancomycin-resistant. Nearly half of staph strains in hospitals are now resistant to methicillin and a family of related antibiotics that disease-causing bacteria are learning how to shrug off once-lethal doses of antibiotics with record speed. Antibiotic resistant strains also are moving from their traditional haunts into the community, while R&D on new antibiotics continues to lag.

Chemistry Versus the Superbugs!

By Becky Ham
include penicillin, oxacillin, and amoxicillin. Methicillin-resistant S. aureus (MRSA) is the term medical people use for these rogue strains of staph, which frequently cause serious infections.

**Dreadful Hospital Discharges**

In addition, antibiotic resistant bacteria are marching out of their traditional haunts in hospitals, nursing homes, and dialysis centers. These new superbugs, termed community-associated MRSA (CA-MRSA) bacteria, are striking high school and college athletes, military recruits, health clubs, prisons, and day care centers. CA-MRSA didn't exist a few years ago. By 2004, however, it accounted for about 12% of serious staph infections in the community.

Ironically, antibiotics like methicillin and vancomycin are losing effectiveness just as interest in developing new antibiotics has sunk to an all-time low. The drugs that launched some of the world’s largest pharmaceutical companies are now less alluring to those same businesses. When Pfizer’s Zyvox (linezolid) went on pharmacy shelves in 2000, it was the first entirely new synthetic class of antibiotics—the oxazolidinone class—in 35 years. Another new class became available in 2005 when the U.S. Food and Drug Administration (FDA) approved Cubicin (daptomycin). Marketed by Cubist Pharmaceuticals, in Lexington, MA, it is the first of the cyclic lipopeptide antibiotics.

The current pipeline for new antibiotics, however, amounts to barely a dribble. One 2004 study published in Clinical Infectious Diseases found that only 6 of the 506 drug compounds under development by the world’s largest biopharmaceutical companies were antibiotics. The study also found that FDA approvals of new antibiotics have dropped by 56% in the past 20 years.

Projan said that the effort to develop new antibiotics “is about 30% of what it was 10 years ago, and that might even be optimistic.”

Antibiotic R&D also has lost its allure for many new scientists, who regard it as a relic of the 20th century. “I hate to say it, since I’ve been in the field for more than 30 years, but it’s not an area that will attract the youngest and brightest,” said Richard White, vice president of Vicuron Pharmaceuticals in King of Prussia, PA. “They’re looking for the great unsolved mysteries—cancer, brain science, the immune system. Microbiology and antibiotics are a bit passé for them, I’m afraid.”

**Tough R&D Challenges**

At first glance, discovering and developing a new antibiotic seems easy enough.

Unlike many other diseases, for example, bacterial infections have a clear-cut cause: Bacteria. Get rid of the offending bacteria and you usually cure the acute illness. Identifying candidate drugs is straightforward. Drugs that work in a test tube or a mouse model will probably work in a patient. There’s a clear endpoint for clinical trials, because bacterial infections respond or don’t respond within definite time periods, which can be as brief as days. And there’s the gratification of knowing that the new drug will be among an elite group in modern medicine, because antibiotics actually cure diseases, rather than merely controlling the symptoms.

However, antibiotic researchers are “competing with 60 years of chemistry,” according to Projan, who said it’s hard to find something that’s as good as, if not better than, antibiotics already on the market.

Current drugs are chemically sound, just a step behind the genetic sleight-of-hand that bacteria use to become resistant.
Bacteria develop resistance in three basic ways: They mutate in ways that slightly change the drug's target, they find ways to pump the drug out of their cells before the antibiotic can work, or they develop cell membranes that won't allow the drug to penetrate.

Here's where the promise—and pitfalls—of chemistry and molecular biology come into play. The last five years of the genome gold rush mean that there are plenty of bacterial gene sequences to mine for new molecular targets, according to long-time antibiotics researcher Molly B. Schmid (ACS ‘03) of MBS Associates in Toronto. In theory, the sequence information should guide the development of antibiotic compounds that attack those targets.

But converting drug targets into drugs “has been a big challenge,” Schmid said. Regular cells may share some of the same targets, so compounds need to be chosen for their “substantial selectivity” for infectious bacteria. “We’re trying to kill bacteria but we certainly don’t want to hurt the patient,” Schmid noted. “We don’t have room for any toxicity.”

**Enter Combinatorial Chemistry**

Combinatorial chemistry also beckons eager antibiotic researchers, often at the expense of the more old-fashioned way of uncovering potential drugs through natural products research, according to White. “People assumed that combinatorial chemistry would replace natural products as a source of new drugs, but it has yet to generate the degree of diversity you find in nature,” he said. “It’s still difficult to routinely and rationally design a molecule, even with advances in crystallography and computers.”

That’s one reason for the lack of antibiotics with a completely new mechanism of action. Linezolid, which broke ground for the oxazolidinones, slows bacterial growth by blocking the assembly of ribosomes, the protein-manufacturing centers within cells.

Because linezolid is the only drug to work this way, it began its reign without any pre-existing resistance within the bacterial community. Unfortunately, some strains of vancomycin-resistant enterococci and methicillin-resistant staphylococci developed linezolid resistance in just a few months.

Daptomycin, the pioneering cyclic lipopeptide, binds to and depolarizes bacterial cell membranes, disrupting DNA, RNA, and protein production within the cell. Like linezolid, the drug targets only Gram-positive bacteria like *Enterococcus*, *Staphylococcus*, and *Streptococcus* and doesn’t affect Gram-negative bacteria like *E. coli* and the bug behind bacterial pneumonia. Unlike linezolid, however, daptomycin kills bacteria outright. Daptomycin resistance remains relatively rare for the moment.

**What’s in the Pipeline?**

Wyeth Pharmaceuticals’ tigecycline (Tygacil) got FDA approval in June, and Vicuron Pharmaceuticals’ dalbavancin was among other new antimicrobial agents approaching the market. Pfizer Inc., which has been collaborating with Vicuron on development of new antibiotics, in June announced plans to acquire Vicuron for $1.9 billion.

Dalbavancin is a glycopeptide drug in the same class as vancomycin and kills several Gram-positive bacteria. The drug is potent against resistant hospital strains of staph bacteria and requires only daily
dosing, which White touts as an advantage over similar antibiotics.

Tigecycline is a semi-synthetic tetracycline drug that seems to be effective against a wide swath of Gram-positive and Gram-negative bacteria. The FDA gave tigecycline priority status in its reviews of new drugs this January.

Then there are telithromycin, oritavancin, ramoplanin, and a handful of other antibacterials that have been either recently approved for use or are still in the midst of clinical trials. The drugs are new members of long-established antibiotic families, developed to evade specific resistance mechanisms, last longer in the body, or attack a broader scope of bacteria.

Some chemists are searching for ways to improve the production of existing drugs. By inserting new genes in E. coli, Stanford University’s Chaitan Khosla (ACS ’91) has coaxed the bacteria to produce polyketide molecules like the antibiotics erythromycin and rifamycin in larger quantities and at faster rates than traditional methods. Khosla, a chemical engineer, said the method is “now being used on a fairly large scale to make preclinical and clinical quantities of therapeutically interesting polyketides.”

Thomas Lectka’s lab at Johns Hopkins University has developed a process that may make it easier to synthesize new members of the beta-lactam class of antibiotics that includes penicillin. The method uses small amounts of quinine to produce large quantities of the particular beta-lactam enantiomer that is useful as a drug.

The New “Antibiotics”

Even while companies look for new twists on old drugs, a handful of researchers have hit upon compounds with antibiotic properties in the course of unrelated basic research. These compounds will complement rather than completely replace conventional antibiotics, their discoverers say.

Vince Fischetti, a microbiologist at Rockefeller University, has returned to the roots of antimicrobial therapy in his quest to develop an antibiotic adjunct. Before traditional antibiotics like penicillin became popular, some researchers pinned their hopes on bacteriophages, viruses that infect bacteria. Now that antibiotic resistance has become a serious problem, Fischetti has revived the idea of using the lytic enzymes produced by bacteriophages to burst open and destroy bacteria before they cause disease.

“Almost all bacteria can harbor a corresponding phage,” Fischetti explained.

University of Wisconsin organic chemist Samuel Gellman (ACS ’81) works with one of nature’s most ancient defenses against bacteria: antimicrobial peptides that rip through bacteria’s outer membrane.

Natural versions of these peptides were battling bacteria long before complicated antibody immunity evolved in organisms like humans, Gellman said. Now, he and his colleagues have designed completely synthetic versions of these molecules called beta-peptides.

Beta-peptides emerged from basic research into how amide polymers fold. Once Gellman and his colleagues had learned enough about controlling the shape of natural and unnatural oligomers, “we found we could give them protein-like and peptide-like functions,” he explained. The synthetic beta-peptides have proved worthy killers of several bacteria, including Enterococcus and Staphylococcus.

New Molecules, New Advantages

The new molecules have a few advantages over natural antimicrobial peptides and traditional antibiotics. First, Gellman and colleagues have tinkered with the structure of the beta-peptides so that they select for bacterial membranes and won’t attack the good guys like red blood cells. And “natural peptides eventually get chewed up by proteolytic enzymes, but the chemical backbone is more resistant in beta-peptides,” Gellman said.

It’s difficult for bacteria to evolve resistance
to peptides because they directly attack the complicated and essential cell membrane, “and it’s a lot harder to modify the membrane than a specific protein target” within the bacteria, Gellman notes. Add that to the fact that the beta-peptides are completely artificial, meaning that the bacteria have never come across their ilk in nature, and resistance is even slower to occur.

The drawback?

Synthetic molecules like beta-peptides are still expensive to produce “on a reasonable scale for what would ultimately be a reasonable cost,” Gellman said. Still, he and his research team believe their peptides might be useful for topical antimicrobial applications, inhaled medications for cystic fibrosis infections, and ways to keep implanted medical devices clean.

Scripps Research Institute chemist Reza Ghadiri has found another way to poke holes in bacteria using a synthetic peptide compound. The peptides, built by joining alternating right- and left-handed amino acids into short chains, form tiny rings that insert themselves into a bacterial membrane and stack together to form nanotubes. The piercing tubes kill the cell by opening up channels in the cell membrane.

The biggest challenge was to make the cyclic peptides selective for bacteria, a feat the researchers accomplished by altering the amino acids used in construction. Ghadiri thinks the nanotubes, like Gellman’s beta-peptides, may elude bacterial resistance for a while because they are completely synthetic.

Cyclic peptide nanotubes are “yet another example of fundamental research that pays off in unforeseen ways,” Ghadiri said. His research team originally worked on nanometal properties, “but it was obvious to us that if you can form a channel you can disable or kill a cell.” In fact, his research team has already shown that the nanotubes can attack viruses and some cancer cells as well.

“We are looking at a supermolecular approach to drug design, not small molecular design like with traditional antibiotics,” Ghadiri explained. The large design space provided by the method gives researchers “a process that can keep up with, or at least combat, a new resistant bug when it arrives,” he added.

The Bottom Line

With all these new ideas and the critical need to overcome resistance, why isn’t antibiotic development a booming field? The simple answer is that it doesn’t pay. Pharmaceutical leaders like Eli Lilly, Aventis, and Abbott Laboratories are among the companies that have recently given up their antibiotic R&D programs, usually in favor of plowing more money into drugs that treat chronic diseases like hypertension and high cholesterol.

“Resistance remains a medical problem but not an economic opportunity,” White said. Patients with the most severe resistant infections—hospital patients—are a paltry few compared with the millions who might purchase the next blockbuster drug like Viagra.

According to many researchers, the real cost of developing a new antibiotic comes from the clinical trials. Projan said running a clinical trial for a new antibiotic can cost between $25,000 and $50,000 per patient. With up to 10,000 participants in a trial, he notes, “it’s not extraordinary for a trial to cost a quarter of a billion dollars.” Tigecycline’s trials were among Wyeth’s longest and most expensive. “If we had known this would take us 12 years to move

![Image](https://example.com/image1.png)

*Based on data reported to the National Nosocomial Infections Surveillance System, 1996-2003, of nosocomial infections among ICU patients. Data for 2003 are incomplete.*

![Image](https://example.com/image2.png)

*Frequencies of hospital S. aureus isolates that are methicillin resistant, based on samples from inpatient, outpatient, and ICU patients. Database composed of pooled isolates from 524 geographically distributed US healthcare institutions, collected from January 1 to December 31, 2003. Only the first isolate was included for a given patient. Specimen sources included blood, respiratory, skin and skin structure, and urine.* (Adapted from Focus Technologies.)
Another reason antibiotic trials cost so much is that they usually take place in hospital populations that require intensive care. Drug companies are also under pressure to prove that their new concoctions are substantially better that the numerous other antibiotics on the market.

“Yow have to show that it’s at least as good as existing drugs, which is not a comparison that you have to do with every cancer drug, for instance,” Projan said. He thinks the FDA could encourage new antibiotic development “by treating drugs for resistant infections more like oncology products.”

Cost is one reason smaller biotechnology companies have become the nexus of new antibiotic development, said White. “It’s commonly quoted that unless a big company stands to make $500 million a year off a drug, they won’t be interested. But $200 to $250 million a year for a small biotech company is good,” he stated.

These smaller companies often license early-stage antibiotics from big pharmaceutical corporations and shepherd their further development. For small companies competing for cash infusions from venture capitalists, licensing gives them a chance to promote nearly market-ready drugs while continuing to fill their pipelines with homegrown discoveries. Big pharma and little biotech may also actively collaborate on drug development, spreading clinical trial costs over two companies.

Schmid believes a lot of big companies have abandoned the game prematurely. “Sometimes you underappreciate how big a market is, and some of those small biotechs will end up being not such small companies,” she predicts.

White said government tax and patent incentives might lure some big companies back to the antibiotic field. The federal Bioshield program, established after the September 11 terrorist attacks and 2001 anthrax scare, hints at some of those incentives and has boosted the profile of antibacterial research. But scientists remain wary about whether the new interest will yield a quick payoff.

“A lot of that money has flowed to places that have very little track record with anti-infective development, to organizations that reinvent wheels, guys that will come to the same points we’re already at,” Projan said.

One Certainty for R&D
The only certainty in the search for new antibiotic heroes is that no one believes in miracles anymore. The story of Fleming’s fortunate accident has to give way to a concerted effort by chemists, microbiologists, molecular geneticists, and health-care professionals. The swift rise of resistance means that the new antibiotics will have to be used alongside a new attitude about how long we can expect the drugs to perform and how often they should be prescribed.

“Nobody has a corner on this market except the bugs,” said Ghadiri. “The more people who engage in this field, the better.”

Alexander Fleming would have agreed. “We are not at the end of the penicillin story,” he said in that 1945 Nobel lecture. “Perhaps we are only just at the beginning. We are in a chemical age, and penicillin may be changed by the chemists so that all its disadvantages may be removed, and a newer and a better derivative may be produced.”

Becky Ham is a science writer in Tucson, AZ. While working on this article, she observed her baby daughter, Jenny, taking the first steps toward a career in drug discovery, apparently searching for a new antibiotic in a pile of dirty bibs.
Thriving in the Midst of Corporate Change

Mergers, acquisitions, and management shifts bring constant change to corporate cultures in chemical and biopharmaceutical industry workplaces. What’s a chemist to do in the midst of these upheavals? Don’t just try to survive. Instead, strive to thrive in the new culture.

If you’re an industrial chemist, you’ve probably found your work world turned upside down at least once or twice in the past five years. You’ve seen corporate mergers (e.g., Dow–Carbide and Pfizer–Pharmacia), foreign ownership (e.g., BP acquiring Amoco and ARCO, Bayer acquiring Aventis and Roche), restructuring and layoffs (e.g., Dupont and Solutia), spin-offs (e.g., NatureWorks and Monsanto), and top management changes (e.g., 3M and HP). The only constant in the world of industrial chemistry seems to be change.

Each upheaval brings a new corporate culture. You’re supposed to carry on with your job, while everything around you seems in flux. What’s an industrial chemist to do when the corporate culture changes?

No wonder you’re occasionally dazed and bewildered. To help you survive—and thrive—in the midst of these upheavals? Don’t just try to survive. Instead, strive to thrive in the new culture.

Adopt a Realistic and Forward-Looking Attitude

Carroll recommends that chemists adopt the approach outlined in Jim Collins’ best-seller, Good to Great: Why Some Companies Make the Leap... and Others Don’t. According to Carroll, the attitude that helps great companies thrive in times of challenge and change can also be applied to chemists in their individual careers.

William F. Carroll, Jr. (ACS ‘73), 2005 ACS president, is vice president for Chlorovinyl Issues, Occidental Chemical Corporation. Carroll’s presidential initiative (“Chemistry Enterprise 2015”) is sparking an ACS-wide discussion of the scientific, economic, demographic, and regulatory trends that will continue to drive corporate change in the decade ahead.

Barbara Peterson (ACS ‘85), a chemical information manager, is currently manager, Global Knowledge Management, Ecolab. She recently retired from 3M, and her career has included industrial employment at several Fortune 500 companies.

This approach, based on the “Stockdale Paradox,” is not one of blind optimism. As first observed by Admiral James Stockdale while he was a prisoner of War in Vietnam, prisoners who were overly optimistic that they’d be released soon, only to have their hearts broken again and again, often died. “The survivors,” said Carroll, “were those who confronted the brutal facts of their reality but never lost faith that they could and would prevail.”

Abou-Gharbia emphasized a forward-looking attitude. “It’s important to avoid looking back and referring to the old way of doing things.” He advised his colleagues, “Let’s try to be open-minded. Let’s look for ways we can contribute to the change. Let’s not resist it; let’s try to be a part of it.”

He cited the example of combinatorial chemistry when it was introduced throughout the pharmaceutical industry. Said Abou-Gharbia, “You found resistance from medicinal chemists in each company. They said, ‘We are doing good medicinal chemistry. Why do we need that?’ But after internal training, they started to realize that there was a good place for it—so we can do our work faster, add quality, and cut the cycle time.”
Communicate, Communicate, Communicate

Peterson said it all: “Communication is the problem—and the solution. As a professor of communications once told me, ‘Remember that all efforts to communicate result in partial misunderstanding.’ So, you need to communicate in as many ways, and in as many settings, as possible. People take in information in a whole variety of ways, so try to meet people where they are now. When you think you’re done communicating, keep going.”

Even in a corporate hierarchy, communication is a two-way process. “Each person has 51% of the responsibility for effective communications,” says Peterson. “In an organization undergoing change, it’s not just the responsibility of the leaders to communicate. It’s also the responsibility of those who are part of an organization to be active listeners—ask questions, get clarifications, and be explicit about expecting communication from your leaders and managers.”

Abou-Gharbia points out that, during times of change, it’s all too easy for groups of individuals to “form silos”—aligning within “us” versus “them” factions and focusing on the faults of the new culture. His advice: “Avoid destructive discussions.”

Actively Manage Your Own Career

In his role as ACS president, Carroll meets with many chemists at all stages of their careers, from students to retirees. He offers similar advice to all of them. “You have two choices: You can keep putting one foot in front of the other and not being attuned to what’s going on around you. Or you can actively manage your career.”

For Carroll, “actively managing your career” means a whole set of behaviors that include:
• picking a career that you feel passionate about;
• being attuned to the environment in which you live, including your corporate culture;
• viewing every job you have as something that contributes to your overall tool kit;
• keeping up your skills with continuing education; and
• becoming the employee who’s too valuable to let go.

One of the best ways to manage your own career is to build and use a network. Said Carroll, “With the dynamic nature of industry today, and particularly as industries and companies in which chemists work get smaller, your network becomes more and more critical. A significant percentage of jobs get filled by word of mouth and never are posted. The way you know about those jobs is your network.” Carroll believes that the ACS is an excellent resource for networking. In fact, he said, “I think this is a fundamental change in the way people utilize their membership in the ACS.”

Calm Seas Ahead?

Is the pace of corporate change going to be slowing down in the decade ahead? Definitely not. Expect to see more mergers, spin-offs, start-ups, restructuring, and new technologies. Expect to get plenty of chances to adapt to corporate change. Expect to make changes in the way you do your job. And, emphasized Carroll, “Never lose faith that you can and will prevail.”

Randy Wedin, Ph.D. (ACS ’77), writes from Wayzata, MN. He launched a freelance writing business, Wedin Communications, in 1992. Before that, he spent a decade “inside the Beltway,” working in Washington, DC, for the ACS and as a Congressional Science Fellow.
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CROSSWORD
BY MARK S. LESNEY

Solution to this puzzle can be found on page 39.

MADAM, I’M ATOM

ACROSS
1. Amount in solution
13. 200 mg of gemstone
14. Plenty of bed ______
15. Used to hear
16. Tale of woe: ___ ___ story
18. Plutonium, in brief
20. Table salt (2 words)
22. Brute
24. Cesium, for short
25. Brute
26. Cesium, for short
27. Eureka!
30. Element with an appointment? for short
32. Fill
34. Phosphorus plus oxygen
36. Nuclear resonance analysis, for short
37. ___ bygones be bygones
39. Atomic absorbance (abbr.)
40. Molecular nasal trigger
41. Unit of measure with wavelengths (abbr.)
42. Joyce contribution to atomic theory
44. Lax
46. Quantities of computer memory
49. Lanthanum, briefly
50. That is (abbr.)
51. Prayerful coda
52. Sheet
53. Bone
55. Biochemical energy source (abbr.)
58. Dream time (abbr.)
59. Tarzan’s “brother”
60. Fall out of solution
63. Caustic chemical
64. Greeting
65. Tubular gas
66. “Tag ___ ___ it!”
67. thine own self be true.
68. RÖRs

DOWN
1. X-ray _____________
2. After work work (abbr.)
3. Require
4. Beige
5. Short for metal in 21 Across
6. Respiratory _____
7. Epidermal disorder
8. Island
9. ___ bygones be bygones
10. Neon, for short
11. Anglophilic heat meas.
12. Mixed atmospheric gas
13. Seeing with wavelengths
14. Kind of shot or rocket
15. Molecular integrated microsystems
16. M. R. Paul, or ruthenium for short
17. Tall tower in Chi town
18. Appropriate
19. Put into solution
20. Mixing method for Bond (not atomic) cocktail
21. Me, myself, ___ ___
22. Portion
23. ____ data interchange
24. Sultanate of _____
25. ___ & ___: problems and solutions
26. Oracles
27. Musical threesome
28. Ben & Jerry unit (non-metric)
29. I cannot tell ___
30. Exercise class (abbr.)
31. Also
"As an inorganic chemist, surely you know what tin did to Napoleon Bonaparte!"

Circulate through the crowd at a big gathering, and you hear bits and pieces of conversations. That's one I collected en route to the drinks at a summer party, and it's still nagging me. I remember a hypothesis that Bonaparte was poisoned during his exile on the island of Saint Helena. But I thought the assassins used arsenic. So what's the story on tin?

Dear Curious,
A sad one involving an allotropic transformation. If you believe the scenario scripted by some historians, it meant disaster for "Le Grande Armée" that Napoleon led on his ill-fated invasion of Russia in 1812. One of tin's allotropes also may have played villain in the disaster that befell Robert Falcon Scott a century later in his quest to reach the South Pole.

First the history:
By 1812, Napoleon ruled most of Europe. When Tsar Alexander decided to withdraw from Napoleon's alliance against Britain, "the Little Corporal" gathered an army of 500,000. In June, they invaded Russia. The army suffered huge losses, but reached Moscow in September. The Russians had evacuated the city, and burned it, destroying food supplies. As the terrible Russian winter closed in, Napoleon withdrew. Troops starved, froze to death, deserted, and were picked off by bands of marauding cossacks. Only a few thousand survived.

Next the chemistry:
Like other elements, tin can exist in different crystal structures—allotropes. The familiar metal used to coat steel cans so they don't rust is "white" or beta tin, which has a tetragonal crystal structure. Cool it below 13.2 °C, however, and beta tin changes into alpha tin, or "grey" tin, which has a cubic structure and is a powder. The colder the temperature, the faster transition occurs.

History and chemistry overlap because some historians have speculated that Napoleon's troops had tin buttons on their trousers and coats. When hunger, disease, and cold were at their worst during the retreat, the soldiers' buttons supposedly went beta to alpha allotropically. The buttons disintegrated, further exposing the troops to the elements.

There's precious little documentation for the scenario, and good reason to question the impact of whatever fallout may have occurred.

One involves price. Despite tin's popular reputation as something cheap, it actually is a semi-precious metal. That's why "tin" cans contain only the thinnest coating of tin. Jeppers! The can would be more valuable than the contents. Wood or brass probably kept Napoleon's army buttoned up. Likewise, if buttons did fall off, soldiers could have jerry-rigged replacements. Just punch a hole in the cloth and tie everything together with a string.

It is hard to believe that better buttons would have enabled Napoleon to conquer Russia, with the rest of the deck stacked so heavily against him. For a great read on the topic, get the 2003 book, Napoleon's Buttons: How 17 Molecules Changed the World, by Penny Le Couteur and Jay Burreson. It connects other lines between history and chemistry, as well.

The same environmental degradation of tin has been proposed as a reason why Robert Falcon Scott and his team of explorers failed and died in their attempt to reach the South Pole in 1912. At supply depots en route, they found kerosene fuel cans empty, apparently because fuel leaked through tin-soldered seams.

Tin's beta-to-alpha flip-flop was first observed hundreds of years ago in pipe organs in European churches, which developed mysterious corrosion. Superstitious people thought it was the devil's work. It got the name "tin pest" and "tin leprosy."

Changes in tin-plating and lead-free solder have been technological nightmares in modern times. They have caused billions of dollars in damage to electronic circuits in space satellites and computers.

One good source of information is a NASA website, http://nepp.nasa.gov/whisker.

—A. K. A. Muridae

—Curious
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Introduce a colleague or friend to the benefits of membership, and in exchange, you’ll receive this custom-made throw, created exclusively for the 2005 campaign. Measuring a generous 57” by 43” and featuring a full-size periodic table of the elements, this throw will look great spread across the back of a couch, tossed over the arm of a chair, or stretched and mounted for display in your home or office.

Claim your throw by recruiting your new member today... access the online application or download a PDF at chemistry.org/membership/mgm.html.

ACS Group Level Term Life Insurance Is Here!

The staff of the Member Insurance Program reminds you that the Program now includes two new plans, for 10-Year and 20-Year Group Level Term Life Insurance. The plans, underwritten by New York Life Insurance Company, include competitively priced rates and benefits guaranteed to remain level for the initial term of coverage. Applying for Group Level Term through ACS offers convenience and flexibility, with up to $2,000,000 in coverage, designed especially for ACS members. And best of all, the plans are portable—coverage continues even if you change jobs.

Term Life is usually the simplest form of life insurance. Now, ACS Group Level Term Life offers one of the most practical forms of life insurance available. Members may take advantage of such new Level Term Life Plan features as coverage for the enrollee and spouse or domestic partner, options for covering dependent children, discounts that save money for eligible members, and a 30-day “Free Look.”

The ACS Member Insurance Program is keeping you covered by expanding its portfolio, thus providing you with plans designed to help meet your needs and give you peace of mind. To receive more information about the new ACS 10- and 20-year Group Level Term Life plans, please visit the ACS website at chemistry.org/insurance or call the plan administrator at 1-800-752-0179. If you have questions regarding the ACS Member Insurance Program, please contact 1-800-227-5558, ext. 2119.

Sponsored by the Board of Trustees, Group Insurance Plans for ACS Members—Your colleagues working for you!

U.S. Chemistry Olympiad Team and Alternates Selected

Four high school chemistry students and two alternates will represent the United States at the 37th International Chemistry Olympiad in Taipei, Taiwan. The American Chemical Society, the world's largest scientific society, sponsored a two-week training camp at the U.S. Air Force Academy in Colorado. The team was selected at its conclusion.

The four regular team members are Allen Cheng and Nicholas Sofroniew, both of the Southern California Local Section; Scott Rabin of the South Florida Local Section; and Jason Sanders of the North Jersey Local Section. Andrew Freddo of the Monmouth County Local Section will serve as first alternate. Michael Blaise of the Southeastern Pennsylvania Local Section is the second alternate.

The U.S. students will be accompanied by two mentors—chemistry professors Nadine Szczepanski (ACS '82) of MacMurray College, Jacksonville, IL., and Roxie Allen (ACS '91) of St. John's School, Houston, TX.

Public Policy Fellowships Available

For more than 30 years, the American Chemical Society (ACS) has sponsored Public Policy Fellowships for working on Capitol Hill, within federal agencies, and in the ACS Office of Legislative and Government Affairs. The 2004–2005 fellows worked for Senator Dianne Feinstein (D-CA), the Senate Committee on Energy and Natural Resources, and the Department of State's Bureau of Verification and Compliance.

Fellows provide science expertise to Washington, D.C., policymakers on issues such as homeland security, national security, water resources and containment, climate change, science education, and much more.

The fellowship applications are reviewed each January while the actual fellowships run for one year, generally from September to September. If you are interested in learning more about these fellowship programs, please visit chemistry.org/government/fellowship.html or call (202) 872-4386 to request an information brochure. Fellowships provide a wonderful opportunity for anyone who has an interest in public policy.

Project SEED: Years Later, a Success Story

When Steve Furyk (ACS '99) entered Project SEED in 1993 after a rocky start in high school, Dr. John Sheats (ACS '61) of Rider University took him under his wing. Furyk received his chemistry Ph.D. from Texas A&M and now works as R&D/MT Chemist at DuPont Chemical Solutions Enterprise. But what became of the mentor-student relationship Project SEED fostered between Furyk and Sheats?

Sheats has mentored at least 70 Project SEED participants in 25 years, a small project for the ACS Scholars Program. The Scholars Program, which is celebrating its tenth anniversary this year, has received almost $3 million in generous corporate funding.

These gifts have helped ACS provide $8 million in scholarships to 1,500 talented students from underrepresented minorities who are pursuing undergraduate degrees in the chemical sciences. In the past quarter, Jacobs met with Lynne Schmidt, PPG Industries' Vice President of Government and Community Affairs; corporate sponsor Mike McGarry; and Sue Sloan, Senior Program Officer of the PPG Industries Foundation, in Pittsburgh. As the Program's Founding Partner, PPG has contributed more than $700,000 to it.

Cecil Pickett, President of the Schering-Plough Research Institute, one of the newest $100,000 National Partners, met with Jacobs at the company's New Jersey headquarters. Schering-Plough Corporation staff from research, public affairs, and the foundation hosted Jacobs for lunch. A trip to Xerox brought Jacobs together with Anne Mulcahy, considered to be the most prominent female CEO among the Fortune 500 companies.

Meeting with the foundation executive and corporate sponsor confirmed the commitment voiced by all of these partners... to continue to work with ACS to change the face of chemistry.

CEO Visits

Madeleine Jacobs (ACS '96) has undertaken a series of visits to thank major corporate contributors to the ACS Scholars Program. The Scholars Program, which is celebrating its tenth anniversary this year, has received almost $3 million in generous corporate funding.

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Anne Mulcahy and Madeleine Jacobs (ACS '96) at Xerox headquarters in Stamford, CT
percentage of the 7,500-plus economically disadvantaged students who have benefited from Project SEED since 1968. Now more than 400 students join the program each summer. Because ACS recently increased the monetary value of the summer stipends, students may more easily opt for worthwhile, educational, and financially rewarding summer employment. In the process, Project SEED helps students appreciate what a scientific research career entails, and it encourages their scientific awareness as global citizens.

For 2006 and beyond, ACS seeks support to help even more students benefit from this unique scientific mentoring experience. A loyal supporter who is also a past member of the Committee on Project SEED challenges ACS members to commit to supporting this program. She will personally match, dollar for dollar, gifts of $2,000 or more to Project SEED.

Getting back to Furyk and Sheats, their collaboration shows firsthand the powerful impact Project SEED and its mentoring relationships can have on the lives of future chemists. At the recent ACS Fall National Meeting in Washington, DC, Furyk and Sheats collaborated on a presentation on cobalt containing polymers. Sheats said, “After all these years, he is a colleague and no longer a student, as we continue our research together.”

For more information about making a gift, visit chemistry.org/gifts or contact the ACS Development Office Mary Bet Dobson, Assistant Director for Individual Gifts, 202-872-4094, m_dobson@acs.org.

Chemagination National Winners Announced

The American Chemical Society (ACS) Office of Community Activities (OCA) and the ACS Committee on Community Activities are pleased to announce the winners of the 2005 National Chemagination contest!

Alternative Energy Sources

Coalspark: The Direct Carbon Fuel Cell
This fuel cell designed for home use is powered by highly refined coal at twice the ordinary efficiency of combustion.
Damascus High School, Damascus, MD
Students: Elliott Biondo, Adam Farrell, and Gregory Iannuzzi
Adviser: Elena Pisciotta (ACS ‘70)
Maryland/Washington Local Sections

Environment

From Handles and Knobs to Fleece and Beyond!
This project envisions using a hydrolytic enzyme to help break the cross-links of thermosetting plastics for recycling.
Albert Einstein High School, Kensington, MD
Students: Bilqis Fassassi, Laura Kranish, and Grace Lerner
Advisers: Ann Coren and Scott Soderholm
Maryland/Washington Local Sections

Medicine/Health

The Transdermal Nutrient System
One square patch for those who can’t have three square meals.
Ridgefield Park High School, Ridgefield Park, NJ
Students: Sana Shah and Alexandra Vargas
Adviser: Christine Iannucci (ACS ‘97)
New York Local Section

New Materials

Geckstickum
Scientists used the technology of Van der Waal’s forces found on gecko feet to revolutionize sports for athletes.
Albert Einstein High School, Kensington, MD
Students: Cory Hawkins and Abigail Hunt
Advisers: Ann Coren and Scott Soderholm
Maryland/Washington Local Sections

Chemagination is a creative innovation and writing contest that the ACS’s OCA developed for high school science students. The contest asks students to imagine that they are living 25 years in the future and have been invited to write an article for ChemMatters, a magazine for high school students that focuses on the role of chemistry in everyday life. Their article is to “describe a recent breakthrough or innovation in chemistry (and/or its applications) and how it has improved the quality of people’s lives today.” The assignment includes designing a cover for the magazine. The contest encourages students to base their ideas on sound chemistry and then develop them.

To find out more about Chemagination or offer a contest in your area for the 2005–2006 school year, please visit chemistry.org/oca or contact the chair of your ACS local section. You may also request Chemagination resources for coordinators and committee members, which are available on CD-ROM, from OCA.

For more information, please contact the OCA at chemagination@acs.org or 800-227-5558, ext. 4458.
Susan Fahrenholtz (ACS ’64) received the Stanley C. Israel Regional Award for Advancing Diversity in the Chemical Sciences. The honor was conferred at the 27th Middle Atlantic Regional Meeting Awards Banquet. ACS President-Elect Ann Nalley (ACS ’71) presented the award on behalf of the ACS Board of Directors and Committee on Minority Affairs. Fahrenholtz’s recognition included a plaque and monetary award. The Israel Award recognizes her commitment to and support of Project SEED and the ACS Scholars Program within the North Jersey Local Section.

The Stanley C. Israel Award for Advancing Diversity in the Chemical Sciences recognizes individuals, institutions, or both. Recipients have advanced diversity in the chemical sciences within their regions. In a significant way, they have stimulated or fostered programs to promote inclusiveness. To nominate an individual, please submit a packet including a letter of no more than three pages, a seconding letter, and a CV or résumé. To nominate an institution, please send a packet including a letter of no more than three pages, a seconding letter, and a brief description of the institution. Please mail nomination packets to the Committee on Minority Affairs, American Chemical Society, 1155 16th Street, NW, Washington, DC 20036. For additional information about this award, please send an e-mail to diversity@acs.org.

Call for 2006 OCA Nominations
The Overcoming Challenges Award (OCA) acknowledges the efforts of undergraduate women who have overcome hardship in pursuit of an education in the chemical sciences. The obstacles they have conquered may be economic, personal, academic, or any combination of the three. Award candidates must be undergraduate women matriculating either in a two-year program or at a four-year school not granting a doctoral degree in chemical-related disciplines. In addition, they must either major or minor in chemical science. The award consists of a plaque, a $250 honorarium, and $1,000 for travel expenses to the fall ACS National Meeting, where the award is presented.

Nominations are due May 1, 2006. Please send them to: Women Chemists Committee; American Chemical Society; 1155 16th Street, N.W.; Washington, DC 20036. For additional information, please contact the WCC at wcc@acs.org or visit http://membership.acs.org/W/WCC.

2006 ACS Women Chemists Committee Travel Awards
Eli Lilly and Company is sponsoring a program that provides travel funding to enable undergraduate, graduate, and postdoctoral women chemists to present their research results at scientific meetings in 2006. Grants apply only to registration, accommodations, and travel to meetings within the United States. Grant funds are limited, but some are set aside for undergraduates. Only U.S. citizens and permanent residents are eligible. Please limit applications to one per research group. In granting awards, the program gives preference to applicants in the following order: (1) Any applicant making her first presentation (in any format) at a national or major meeting. (2) Graduate or postdoctoral applicants who have not presented at a national or major meeting since leaving undergraduate school. Women who have received a prior award under this program are ineligible. Application deadlines are September 15, 2005 for meetings January 1–June 30, 2006; and February 1, 2006 for meetings July 1–December 31, 2006. For detailed information about this award and how to apply, please visit the Women Chemists website at http://membership.acs.org/W/WCC/ or contact the WCC office at wcc@acs.org.

Chemvention Contest for Student Affiliates
Members of the Committee on Community Activities and the Office of Community Activities (OCA) have begun preparations for National Chemistry Week (NCW) 2005. ACS Student Affiliates have always been a big part of the celebration! We will again offer the Chemvention competition to active SAACS Chapters, and we would like your help in the planning process. If you have suggestions, please call OCA at 800-227-5558, ext. 6078, or e-mail oca@acs.org.

The winner in the 2004 Chemvention Competition, for the second year in a row, was the University of Scranton. The Chemvention challenge for 2004 was to develop a colorimetric test to measure the amount of albumin in an aqueous solution of powdered egg whites as accurately and precisely as possible. The challenge for 2005 has yet to be announced, but it will relate to the NCW theme: “The Joy of Toys.”
National Chemistry Week: “The Joy of Toys”

Each year the American Chemical Society’s National Chemistry Week (NCW) campaign reaches millions of people with positive messages about the contributions of chemistry to their daily lives. It is the one time during the year that chemists unite with the common goal of spreading the word that chemistry is good for our economy, our health, and our well-being.

The celebration dates for 2005 are October 16–22 with the theme, “The Joy of Toys.”

It is not too late for you to join the celebration!

Some ways that you can contribute to the NCW campaign are: performing chemical demonstrations at a neighborhood school; conducting hands-on activities with children at museums, malls, or libraries; or writing articles or letters to the editor of your local paper.

Contact the Office of Community Activities (800-227-5558 ext. 6097; ncw@acs.org) or visit chemistry.org/ncw to learn more!

ACS Directory of Graduate Research 2005

The ACS Directory of Graduate Research 2005 is the premier source of information about faculty and their research programs in chemistry, chemical engineering, biochemistry, and related chemical sciences in the United States and Canada. It lists each faculty member’s biographical information, area of specialization, titles of all papers published within the last two years, individual telephone number, and fax number. The Directory also contains listings for more than 600 academic programs, 10,000 faculty members, and 100,000 publication citations. DGRweb 2005, the online version of the DGR, will be available for free when the latest edition is released in the fall of 2005! DGRweb is a fast, efficient search engine that contains all of the information in the print version of the Directory. With DGRweb 2005, you can search for faculty by virtually any field in the DGR, including specific research area, academic rank, gender, and state. Take DGRweb 2005 for a spin when it is released in late October at chemistry.org/education/DGRweb.

Expatriate Networks Help Home Chemists

ACS members provide and share professional service, knowledge, and expertise worldwide. About a third of the chemical R&D professionals from Africa, Asia, and Latin America have opted to work in more developed countries. The ACS Office of International Activities (OIA) uses its extensive network to help expatriate chemists boost training and professional development in their home countries.

OIA informational interviews revealed several ways chemists can assist their home countries by creating various networks. Some could promote regional and interdisciplinary research and encourage chemists to prepare proposals and coauthor translationally. Others might notify local scientists of international speakers or visitors going to their regions. Networks to share information about the function and availability of analytical instrumentation (equipment and spare parts) could prove extremely useful. And networks could also help assure the quality and improvement of secondary and university chemistry curricula, instruction, and teacher training.

If your adopted home is the United States and you want more information, please contact the ACS Office of International Activities at intlacts@acs.org or 202-872-4088.

Reaching Potential Graduate Students

Through the ACS Student Affiliates Program and its quarterly magazine, in Chemistry, graduate institutions and professional schools can reach over 11,000 Student Affiliates—highly motivated undergraduates working toward degrees in the chemical sciences. in Chemistry is mailed to all Student Affiliates, more than 900 faculty advisors of Student Affiliates chapters, 1,500 chairs of chemistry departments, 1,300 two-year colleges, and 300 predominantly minority-serving institutions.

In addition to highlighting graduate programs, in Chemistry includes articles on special topics in chemistry, careers, professional development and workplace issues, and guest editorials. It also features Student Affiliates chapter activities and other topics of special concern to undergraduates.

The November/December 2005 copy of in Chemistry will feature articles on graduate school interviews, undergraduate research, and graduate school letters of recommendation.

If you would like to reach this highly qualified pool of potential applicants by showcasing your graduate school in in Chemistry, please e-mail a_chambers@acs.org for more information. Student Affiliates are waiting to hear from you!
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For more information, call 800–227–5558, toll-free, or e-mail help@acs.org.
Continuing Education

Today's chemistry graduate may change jobs 20 times in a typical career, working for companies that also are constantly changing product lines and research goals. This new era in employment makes learning how to learn absolutely essential.

I find that I read the Sunday comics with a little more enthusiasm now than a few years back. Berkeley Breathed has returned. He is, of course, the author, illustrator, and spiritual guide of Bloom County, a comic strip whose collection of characters chronicled their—and by inference our—lives through the 1970s and '80s. It was one of the more ironically insightful commentaries on that time. Breathed ceased writing and drawing Bloom County in 1993.

But fortunately for his readers, after a decade, he returned from sabbatical with a Sunday strip he calls Opus, eponymously named for his everyman penguin protagonist.

In the very first of his renewed strips, Opus fantasizes about a Gauguin-style retirement to a South Sea Isle with lush breezes and beautiful women. Reality turns out to be an Antarctic frozen landscape with a mean-looking companion, only vaguely of the opposite sex, who threatens violence.

The punch line is Opus, speaking directly to the audience, saying, “Oh, and I suppose you’re where you thought you’d be in ten years?” Speaking from my own experience and as an observer of fellow chemists, I think many of us are nowhere near where we thought we would be ten years ago. But one way or another, it’s notable that most of us continue to work in chemistry, the science in which we were trained.

Making Change a Career

A decade ago, I worked for a major instrument manufacturing company. Before that, I worked for places such as the Environmental Protection Agency and a contract research organization in Louisiana. Since 1997, as some readers may know, I was the editor of Today's Chemist at Work (TCAW) magazine. But in a financially necessary decision, the management of the American Chemical Society ceased publishing TCAW as of December 2004.

So now I work as part of the ACS Continuing Education group responsible for the Society's Short Courses program. These programs offer chemists a means of improving their technical skills and hearing from key research scientists about the latest accomplishments in polymer chemistry, organic chemistry in drug discovery, laboratory management, proteomics, statistical experimental design, and similar technical areas.

Our group also manages the ACS Prospectives Conference program, a series of focused forums that explore chemistry's role in advancing the interdisciplinary molecular nature of life science, toxicology, nanotechnology, and even engineering.

What I find interesting about working as part of the ACS Continuing Education group is that I see people taking courses and attending conferences whose careers seem comparable to my own. They started out in a lab practicing chemistry that was analogous to their university or college training.

But every five to seven years, a career change has taken them down a different path, in some cases away from the lab bench to plant manufacturing or perhaps raw material acquisition, technical management, or international trade policy.

Many find themselves working in administration in such areas as environmental regulation or homeland security. Some manage chemists and technicians in local water quality or state forensic labs. Those who remain in careers related to the laboratory often find themselves working with technologies that were cutting edge and only available in the most sophisticated research environs less than a decade ago.

The 20-Job Career

Now these technologies are used in hundreds of labs in a near-routine manner to decode genomes, identify proteins, and discern drug targets. People who received their bachelor’s or master’s degrees in the 1980s or even the 1990s now have to operate instruments, and more importantly design experiments and evaluate data, in areas where they have had no formal training. At one chemical job fair this year, a speaker noted that those who graduate today in chemistry may find themselves with as many as 20 different jobs in their careers, most with different organizations.

Add to this the new face of business today, for not only is it jobs of chemists that have changed, but also the companies that employ them. DuPont, a name synonymous for most of the 20th century with synthetic fibers such as nylon, rayon, Dacron, and Orlon, has completely exited that business. Union Carbide no longer exists, and neither does Upjohn or Pharmacia, the company that acquired Upjohn.

Hewlett-Packard, home to some of the
most sophisticated electronic and chemical equipment of the 20th century, has spun off that business and now concentrates on computers and printers.

General Electric, once the manufacturer of toaster ovens and coffeemakers, has entered the life sciences market as GE Healthcare with the acquisition of Amersham Biosciences. Though it may sound trivial to say, the only constant in employment today is change.

Tom Friedman, an op-ed columnist for the New York Times, wrote recently that “…my own research has taught me that the most important thing you can learn in this era of heightened global competition is how to learn.” He was referring to teaching our children how to compete in this new world, but he could just as well have been referring to our own generation.

Like Opus, very few of us are able to predict where we will be in ten years. But as chemists, the chances are good that we can build—and rebuild—on the fundamentals of our chosen discipline.

Jim Ryan’s (ACS ’67) varied career in chemistry included seven years serving as editor of Today’s Chemist at Work magazine, where his commentary was must reading for chemists in industry. His new column will appear regularly in Chemistry.
You can find us at...

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- ACS  
  chemistry.org
- CAS Web server  
  www.cas.org
- Education Division home page  
  chemistry.org/education
- Insurance  
  chemistry.org/insurance
- CEN-chemjobs  
  cen.chemjobs.org
- Minority Affairs  
  chemistry.org/minorityaffairs
- Publications home page  
  pubs.acs.org
- Women Chemists Committee  
  membership.acs.org/w/wcc
- Younger Chemists Committee  
  chemistry.org/ycc

### E-Mail Boxes

| ACS Scholars program  | scholars@acs.org |
| Career and employment services  | career@acs.org |
| Chemical Abstracts customer service  | help@cas.org |
| Chemistry Olympiad  | c_hernandez@acs.org |
| Corporation Associates  | ca@acs.org |
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