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Few people know that the Hubble Space Telescope (HST), now revolutionizing knowledge about the universe, almost was named the Spitzer Space Telescope.

The late Lyman Spitzer, Jr., a Princeton University astrophysicist, played a pivotal role in HST’s origins. He proposed construction of a large space telescope in 1946, helped design it, and nurtured it through funding and construction. Colleagues thought it should bear his name. NASA, however, balked at naming the orbiting telescope after a living person, and Spitzer then was very much alive.

When interviewing Spitzer for a story, I posed one of those philosophical questions—from-left-field that scientists should occasionally expect from science writers. How could the human mind ever imagine the sheer immensity of the universe? After all, our galaxy—the Milky Way—has perhaps 100 billion stars, and there may be 100 billion such galaxies in the universe. Didn’t he, too, have a problem conceiving of it all?

No, Spitzer responded. What he found really mind-boggling were ordinary chemical phenomena in the world around us. He found rapid oxidation—fire—especially hard to imagine. If fire didn’t exist, Spitzer mused, nobody would believe it possibly could exist. And he marveled at how humans and other complex life forms originated from simple organic chemicals.

Spitzer might have enjoyed this edition of Chemistry, with one article on astrochemistry’s search for the origins of life and another on science’s war against fire.

Like other Chemistry content, the articles are not written as comprehensive reviews for scientists who are working in those disciplines. Rather, they aim to give chemists for scientists who are working in those disciplines a snapshot of another, not-so-familiar, field. Astrochemists may learn something from Barbara Maynard’s feature on fire, and Joe Alper’s feature on science’s war against fire.

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Spitzer might have enjo...
Singin’ the blues
Few mysteries have made chemists sing the blues longer than the nature of those giant molecules, or supramolecular structures, that form in solutions of molybdenum and oxygen.

“The nature of ‘molybdenum blue solutions’ has remained a fascinating enigma for inorganic chemists since the late 1700s and early 1800s,” said Tianbo Liu (ACS ’99) of Brookhaven National Laboratory in Upton, NY.

Liu and associates have become the enigma busters.

Using static and dynamic laser light scattering, they deciphered the structure of the big polyoxomolybdate (POM) molecules that form in molybdenum solutions and confer the blue color. The molecules have a chemical formula of Mo$_{5}$O$_{14}$.

Unlike table salt and other soluble inorganic compounds, giant POMs do not occur as single ions in water. Rather, POMs cluster together. Scientists did not understand the structures of the aggregates.

“One once found how big these molecules were [2.5–5.1 nanometers, or billionths of a meter], we realized we could use laser light scattering to decipher the structure,” Liu explained. It enabled Liu to determine the radius, size distribution, mass, and other characteristics of the clusters. Liu concluded that individual POM molecules assemble into hollow, spherical structures with an outer surface that resembles a blackberry.

The solution to the structural enigma led to another mystery: What’s the physics behind the structure? Sodium and chloride ions distribute evenly in a solution to maintain charged neutrality. The charged particles in proteins form large clusters that precipitate from solution. But POM clusters stay in solution.

“We believe we are seeing a new, thermodynamically stable state for solutes, where large-size, single molecules with a limited amount of charge on the surface will all form hollow spherical clusters,” Liu said.

He reported that some other giant molecules with different shapes also assume the blackberry structure, further suggesting that it may be a universal state for certain solutes.

Green dry-cleaning
Liquid carbon dioxide has been the dry-cleaning industry’s great hope as a permanent replacement for chlorinated solvents like perchloroethylene, which have potential health and environmental risks.

CO$_{2}$ avoids those toxicity problems yet works much like traditional dry-cleaning solvents. Thanks to low surface tension and viscosity, it easily penetrates garment fibers and dissolves dirt, grease, and oils in a wide range of fabrics. Nonflammable and odorless, it produces no hazardous waste or emissions that require special equipment.

Thousands of dry-cleaning establishments already use CO$_{2}$ cleaning fluids, which usually require additives, including surfactants based on compounds of silicon or fluorine, to enhance their dirt-busting power. Imperial Chemical Industries, London, and the Linde Gas Group, Wiesbaden, Germany, reported development of a “revolutionary” dry-cleaning fluid called Washpoint that could expand the use of CO$_{2}$. Washpoint contains an additive that greatly enhances CO$_{2}$’s cleaning power. The firms did not disclose the additive’s identity because it is proprietary, or a trade secret.

CO$_{2}$ dry-cleaning is a spin-off from the aerospace industry, which years ago developed a supercritical fluid technology to clean high-tech metals and composite materials. Supercritical fluids are at a temperature and pressure greater than or equal to the critical temperature and pressure of the fluid. CO$_{2}$’s critical pressure is about 1070 pounds per square inch, and its critical temperature is about 31 °C.

H$_{2}$O: The action movie
H$_{2}$O gets a lot of press for a simple molecule. Scores of new research papers on water and ice appear annually. Now scientists at the Lawrence Berkeley National Laboratory have produced an action movie starring individual water molecules. It has a surprise ending.

Miquel Salmeron and co-workers put water molecules on a single crystal of palladium and used a special scanning tunneling microscope (STM) to track their motion. As expected, single molecules migrated across the surface to aggregate into clusters of dimers, trimers, tetramers, pentamers, and hexamers.

The surprise, they reported in the September 13 edition of Science, came from the molecules’ motion.

“Isolated water molecules moved by hopping from one lattice point [on the substrate’s crystal] to the nearest neighboring point, whereupon if they collided with another water molecule, they began to form clusters,” said Salmeron. “The speed with
which the molecules moved increased by four orders of magnitude when dimers were formed. The mobility of trimers and tetramers was also very high compared to the isolated molecules."

That didn’t follow the script, in which single molecules should diffuse or move across a surface more rapidly than clusters. STM action films could reveal more surprises about water’s behavior on surfaces, a topic which has commercial implications. It’s the basis of commercial coatings that protect surfaces from stains, mildew, and rust. Water–surface interactions also drive corrosion, wetting, dissolution, ice-melting, electrochemistry, and solvation. Such interactions are important in biological processes as well.

“Numerous fundamental questions regarding the adsorption of water on surfaces and its evolution from isolated molecules to clusters, complete layers, and beyond, remain unanswered,” noted Salmeron. “Structural probes that analyze cluster formation do not address the important issue of the movement of water on surfaces.”

The STM, in contrast, is ideal for studying diffusion of individual molecules or atoms along the surface of a material, Salmeron added.

**Better than gold**

**DOES GOLD TARNISH?**

Silly question. Humans have lusted after gold since its discovery 7000 years ago partly because its glitter lasts forever. Gold sits atop the electrochemical series for metals, with an electrode potential of +1.5 V, indicating great corrosion resistance. Only aqua regia (nitric and hydrochloric acid) can corrode the noblest of the noble metals.

Right? Not quite.

Gold does oxidize, forming Au₂O₃ when exposed to ozone or other highly reactive chemical environments, atomic oxygen delivered by molecular dissociation at a hot filament, or radicals produced by an oxygen plasma.

Hans-Gerd Boyen, of the University of Ulm in Germany, led a German–Swiss research team that discovered a more oxidation-resistant form of gold. The material is Au₅₅. It consists of clusters of gold particles about 1.4 nanometers in diameter. Boyen’s group found that the 1.4-nanometer size in Au₅₅ produced minimum reactivity. Au₅₅ resisted corrosion under conditions that corroded ordinary gold and gold clusters consisting of nanoparticles with both a larger and a smaller diameter.

Boyen believes the stability is due to the cluster’s closed-shell atomic structure. He speculated in the August 30, 2002 issue of *Science* that Au₅₅ clusters may have unusual catalytic properties. One potential use is in catalysts for oxidation reactions that convert carbon monoxide into carbon dioxide, he said. Catalysts based on Au₅₅ would not be affected by the atomic oxygen present during the reaction.

Super-duper D

Hector DeLuca’s landmark studies have rewritten biochemistry and medical textbook sections on vitamin D, leading to new treatments for bone diseases. DeLuca, a biochemist at the University of Wisconsin–Madison, defined a whole new hormonal system—sometimes called the “vitamin D endocrine system.” It controls how the body absorbs calcium from food, regulates calcium’s concentration in the blood, and determines its transport into and out of bone.

Now DeLuca and co-workers have synthesized a potent new vitamin D analog called 2MD that stimulates bone growth, holding promise for the estimated 44 million Americans threatened by osteoporosis. The Wisconsin group’s studies in the lab and in animals suggest that the compound could lead to development of a class of drugs that reverse bone loss in humans suffering from osteoporosis.

“This is the most promising vitamin D compound I’ve seen,” said DeLuca, whose previous analogs got the moniker “super vitamin D.” “We’ve got a compound that is very selective for bone,” DeLuca said. “It is very effective in animals,” increasing bone density significantly in rats with a condition that mimics human osteoporosis, and can be used in the lab to grow bone in culture. Their report on the compound, 2-methylene-19-nor-(205)-1α,25(OH)₂D₃, appeared in the September 30, 2002 edition of the *Proceedings of the National Academy of Sciences*.

DeLuca stressed, however, that although the new compound has shown astonishing results in experimental animals, the first tests in humans still lie ahead.
Order in the court (of amorphous materials)!

The curtain is rising on a promising new field—amorphous materials engineering—in which chemists and other scientists may orchestrate the structure of glasses and liquids. The result may be a symphony of new materials with useful optical, electronic, and mechanical properties.

That’s the conclusion of James D. Martin (ACS ’85) and his co-workers at North Carolina State University, Raleigh. They applied principles of crystal engineering to design-specific patterns of intermediate-range order in amorphous zinc–chloride networks. It’s a step toward working out the structure/property relationships needed to make custom-designed amorphous materials.

Hold your horses! Order in amorphous materials?

Elementary chemistry textbooks define amorphous materials—liquids and glasses—as being “without structure.” Cartoon-type graphics reinforce it, often portraying liquids, for instance, as similar to gases, with molecules darting around at random.

Actually, scientists have known since 1916 that even liquids have some structure. Ranking somewhere between chemical bonds and crystalline lattices, it is termed intermediate-range order.

“Just as a symphony is much more than a collection of random notes, the atoms and molecules in a liquid are quite organized—more like those in a crystal than a gas,” Martin said.

That knowledge underlies efforts to reorganize amorphous materials. Martin and his colleagues have discovered the chemical principles that allow them to essentially write new “symphonic compositions” in amorphous materials.

As reported in the September 26, 2002 issue of *Nature*, the researchers designed the compositions and structure of several glasses and liquids, then made the materials in the laboratory.

Martin got interested in the topic years ago after noticing that liquid and glassy blobs appeared during the synthesis of crystals. After first dismissing the blobs as trash, he started to wonder why they appeared so often. It led him to the study of the molecular structure of liquids and glasses, an area not well understood by science. •
IUPAC Compendium of Chemical Terminology
www.chemsoc.org/chembytes/goldbook

ALKANES AND ALKENES AND ALKynes. That can be an “Oh my!” for students. For those seeking to nail down a chemical definition, this is the place to go. Hosted by the Royal Society of Chemistry, this site features the International Union of Pure and Applied Chemistry’s Compendium of Chemical Terminology. It’s a comprehensive chemistry dictionary, an updated and improved version of the 1997 print edition of the so-called Gold Book. The result, says the site, “is a collection of nearly 7000 terms, with authoritative definitions, spanning the whole range of chemistry.” Searches can be based on single terms or on free text (with an option for a Boolean search on the latter). Results are returned initially as regular Web pages, with partial definitions, but there's a clickable option to continue to a PDF page with the full definition and HTML-style clickable links. For example, “alkanes” leads to “cycloalkanes,” which links to “olefins,” “acetylenes,” and “alicyclic compounds.” The “olefins” link leads in turn to “hydrocarbons,” “aromatic compounds,” and “alkenes.” Just browsing the various interconnected links could turn into an absorbing activity for those with enough time on their hands.

Bill Hammack’s Engineering & Life
www.engineerguy.com

SCIENTIFIC ILLITERACY is like the weather: A lot of people complain about it, but who ever does anything? Well, count Prof. Bill Hammack (ACS ’87) of the University of Illinois, Urbana–Champaign, among the doers. In the late ’90s, Hammack, a chemical engineering professor, pursued TV as a way to reach a wider public audience, but couldn’t interest anyone in a project based on science and engineering. So he turned to radio, and the result, every week since August 1999, has been “Engineering & Life,” beaming forth from the university’s public radio affiliate, WILL-AM. Now, after 150 segments covering topics from bathtubs to windshield wipers to that exotic musical instrument, the theremin, Hammack is convinced that radio is the better medium after all. “In radio, you can do small pieces” that are more likely to hold someone’s attention from start to finish, he explains. The segments are only 3 minutes long, but Hammack spends 6 hours researching and writing each. The site offers a complete “Engineering & Life” archive, with many files in audio, so you can hear Hammack first-hand.

Chemistry animations and movies on the World Wide Web
www.klte.hu/~lenteg/index.html

IT’S PRETTY EVIDENT that Gábor Lente (ACS ’02), a research associate in the Department of Inorganic and Analytical Chemistry at Hungary’s University of Debrecen, is smitten with the movies. For instance, one page on his website is stocked with his favorite quotes from Woody Allen's movies. And that love carries over into the page cited in the title above, a listing (with links) of more than 100 chemistry animations and movies on the Web. Want an animation of the Diels–Alder reaction? The link is here. Nobel laureate Sir Geoffrey Wilkinson speaking on organometallic chemistry? Got it. A simple animation of alkene hydrogenation or of Rutherford’s gold foil experiment? Got it. Got it. On the fun side, the explosions in a Quicktime movie about dynamite at the Oxford University site, though small, would do an Arnold Schwarzenegger movie proud. Another part of Lente's site is a page with links to about 450 chemistry-related journals on the Web. Lente, 28, was a silver medalist in the 1992 International Chemistry Olympiad, and won a Fulbright Fellowship to Iowa State University.
WILLING TO TRY a Net search engine that’s more interesting, and possibly more productive, than Yahoo! or Google? If so, KartOO would be well worth looking at. This wonderfully interactive metasearch engine (whose pointy-eared, green-fezzed mascot looks like an escaped Disney character) queries other search engines, then displays the results as a series of conceptual maps. Each site on the initial map appears as a ball, its size corresponding to the site’s relevance to your search. The colored lines linking the sites are labeled with words or phrases (“semantic links”) that indicate how the sites are related. (The specific colors are meaningless.) To help you keep your bearings, successive maps have some overlap with each other. It’s interactive in the sense that you can continually add, or eliminate, topics in your search. Searching on “prion,” for example, came up with topics like “spongiform encephalopathy” and “infectious diseases.” As with all Web searches, however, the operative principle is still “caveat surfer.” Though it may take a bit of practice to use KartOO’s features well, it could be worth checking out. KartOO is also multilingual (the development team is French).

Singing Science Records
www.acme.com/jef/science_songs

IN THE ‘60S, Jef Poskanzer’s parents gave him and his sister a six-LP set of “science-themed folk songs” from a series called Ballads for the Age of Science. Poskanzer’s favorites among the albums were “Space Songs,” “Energy & Motion Songs,” and “Weather Songs,” which were performed by Tom Glazer, whose greatest claim to fame otherwise is having written that immortal children’s classic “On Top of Spaghetti.” The other albums were “Experiment Songs,” “Nature Songs,” and “More Nature Songs.” Even when hokey, the songs are often infectious, partaking of musical influences from calypso to ragtime, with the occasional pop or scratch betraying their vinyl origins. Would you believe a chirpy song called “Longitude and Latitude,” more or less to the tune of “Ach, Du Lieber Augustine”? In 1998 Poskanzer, by then a Berkeley, CA-based software engineer, rediscovered the treasured vinyl in his parents’ basement and eventually digitized all 80-odd songs to MP3 format and posted them to his site. Since the songs are usually well under 3 minutes in length, download times are reasonable, leading to a noticeable “just one more” effect. Be sure to check out the lyrics from the tune “Chemical Energy.”

The Internet Archive: Building an “Internet library”
www.archive.org

THANK GOODNESS SOMEONE is saving copies of the Web that vanish, often without explanation. Internet Archive aims to build a “library of Internet sites and other cultural artifacts in digital form.” The archive’s main feature is the Wayback Machine, which lets users surf long-gone websites. Did one of your favorite sites disappear at some point? There’s no telling what the odds are of finding it again, but the Wayback Machine currently contains over 100 terabytes of data (that’s over 100,000 gigabytes) and is growing by 12 terabytes a month. According to the Archive, it’s the world’s largest known database, bigger than the Library of Congress. If you can’t think of any archival websites you’d like to search, the Wayback Machine has several special collections, including one for the 2000 presidential elections and one for the September 11 terrorist attacks. A different section of the Archive site is devoted to preserving documents (surveys, mail, technical papers, etc.) from the Internet’s progenitor, ARPANET, the computer network pioneered by the Department of Defense’s Advanced Research Projects Agency.
**Quick Hits**

**The Nanotechnology Simulation Hub**
nanohub.purdue.edu

First envisioned in 1959 by noted physicist Richard Feynman, nanotechnology has earned increasing credibility within the past few years. This site, cosponsored by the National Science Foundation, is more than a collection of information and links. It's a virtual lab, with a suite of browser-friendly nanotech simulation tools available for use by registered users. Registration is free.

**The Probability Web**
www.mathcs.carleton.edu/probweb/probweb.html

"Probability theory is nothing but common sense reduced to calculation," wrote the French mathematician Laplace. He would have liked this site, and not just because it includes this quote. Hosted by Carleton College in Minnesota, the Probability Web features an array of resources on probability, including links to abstracts, journals, and books; probability societies and conferences; and software. In addition, a new page on teaching resources includes links to interactive demonstrations and online tutorials.

**Electronic Journal Miner**
ejournal.coalliance.org

The Colorado Alliance of Research Libraries assembled this index to "electronic serial publications" on the Net. Users can search on keywords, subjects, or titles; limit searches to free or peer-reviewed publications; or just browse by alphabetical Library of Congress headings. A quick look under "Polymers—Research," for instance, turned up five e-journals on this topic published in the United States or the United Kingdom.

**AcroMed and IUB Acronyms Database**
medstract.org/acro1.0/main3.htm
129.79.137.107/cfdocs/libchem/searchu.html

AcroMed is a computer-generated database of biomedical acronyms. Search by acronym, full name, or alphabetical index, and end up with not only the definition (or acronym) but also a journal citation using the acronym. The Acronyms Database at Indiana University–Bloomington is more broadly science-based. It missed ZASA (zinc 5-aminosalicylate) but found WSC (water-soluble carbodiimides).

**Medicine and Madison Avenue**
scriptorium.lib.duke.edu/mma

This selection of health-oriented print ads from 1911 to 1960 includes products like insecticides and household cleansers in addition to vitamins and over-the-counter drugs. Typical of these fascinating period pieces is a 1945 newspaper ad for My-T-Kil Spray, “whose chief ingredient is that miraculous chemical called D.D.T.,” for sale at Bloomingdale’s.

**Looney Tunes**
looneytunes.warnerbros.com/looney_theater


**Scott Baltic is a writer in Chicago.**
International fellowships abound, but two programs warrant special consideration for applicants in 2003. One is the old, prestigious Fulbright program. Newer and less well known is the NSEP, which offers excellent opportunities for broadening scientific and other horizons.

Want to know how to jump start that chemistry career, see the world, and serve your country in one fell swoop? Joining the military may be one answer. But consider another route. It involves a shorter commitment of time and a better venue for developing your skills as a chemist: Study abroad with the help of one of the two fellowship programs sponsored by the U.S. government through the Institute of International Educators (www.iie.org). Application information is available at the website.

The Fulbright Fellowship, available to newly graduated baccalaureates, and the National Security Educational Program (NSEP), offered to current undergraduates at U.S. colleges and universities, provide an opportunity to conduct research and study in virtually any country abroad. The separate Fulbright Scholar Program also offers work-abroad opportunities for faculty and professionals.

Parallel programs are available for foreign students, faculty, and professionals to study in the United States. Although none of these programs is designed specifically for those with an interest in chemistry, program administrators say that they are always on the lookout for scientists in general, and chemists in particular, to participate in all of these programs. “If chemistry-oriented scholars apply for these programs, the chances of winning one of the awards are very high,” said Theresa Granza, IIE’s director of U.S. Student Programs.

The Fulbright Fellowship is the granddaddy of all foreign scholar programs. Started in 1946 and named in honor of the late Sen. J. William Fulbright, who sponsored the legislation creating this initiative at the end of World War II, the program was designed to increase mutual understanding between citizens of the United States and other countries through the exchange of people, knowledge, and skills.

Funding comes primarily from the U.S. State Department, though participating countries and research institutions provide a small amount of support by providing tuition waivers, university housing, and other benefits. IIE, a nonprofit organization, was established in 1919 to administer the program for the State Department.

Fulbright Fellowships are awarded on a country-by-country basis and last up to a year depending on the country. For example, in the 2001–2002 competition, 90 fellowships were available in Germany, each lasting 10 months. An additional month of German language training was also offered as part of the fellowship. In the United Kingdom, 12 full-year fellowships were offered; 18 fellowships were available in Japan, though none were given to science students in that particular round. For those wishing to travel to more exotic locations, 9 fellowships were available in Morocco, 10 in the Ukraine, and 12 in Brazil, among others. All told, 140 countries participate in the Fulbright program.

The application period for Fulbright fellowships opens in March and closes in October for the following year’s awards. The research proposal is the heart of the application. Each prospective fellow must develop a specific research project to conduct in the host country. Preference is given to applicants who can designate a specific university or research institute and supervising researcher.

“You’d go about preparing the research proposal in much the same way that you’d approach any postdoctoral fellowship,” explains Granza. Applications are then reviewed by a committee of scientists, and awards are made soon after the first of the year. “Most of the applications we get from science students are well thought-out, and the majority of them are approved,” said Granza.

For the 2001–2002 grant cycle, 9 students were awarded Fulbrights for chemistry-based projects, which included a project in France to conduct a microspectroscopic study of synthetic oligonucleotides within living cells and one in the Philippines to work on the Golden Rice project aimed at improving the nutritional qualities of rice using genetic engineering.
NSEP: No specific research requirements

Less well known than the Fulbright Fellowship, the NSEP was first offered in 1994, the result of legislation sponsored by then Oklahoma senator David L. Boren, who is now president of the University of Oklahoma. Upon introducing the legislation, Sen. Boren explained why he felt the program would be important:

“One of the greatest needs we have in this country, as we enter a new world environment, is to internationalize the thinking of the next generation of Americans. How in the world are we going to go out and compete economically, how are we going to be politically involved, if we don’t speak the languages of the world, if we don’t understand the cultures of the world? How in the world are we going to be ready to go out into a new international environment and hold our own when the next generation of Americans doesn’t seem to have an understanding that it’s an international environment in which they’re going to be living and competing? We must change.”

Unlike the Fulbright program, which is project-oriented, the NSEP is designed as a horizon-broadening experience with no specific research requirements, though most participants do engage in a research project. Since the first competition in 1994, over 5900 students attending more than 750 U.S. colleges, universities, and community colleges have submitted applications for NSEP scholarships to study abroad, and 1380 scholarships have been awarded.

These applicants proposed study of 75 languages and cultures in 80 countries not commonly chosen by Americans as study-abroad destinations. In fact, the program specifically excludes Canada, Australia, New Zealand, the United Kingdom, Ireland, Iceland, Austria, Belgium, France, Spain, Portugal, Germany, Italy, Norway, Sweden, Finland, Denmark, the Netherlands, Switzerland, Luxembourg, and Greece from the list of possible countries. The list of approved countries is available at the IIE website, and applications are available there beginning in June.

One requirement of the NSEP scholarship is that participants make a good-faith effort to secure work with a federal agency within eight years of graduation. Though this may seem difficult in an era of budget deficits, participation in NSEP will give you special hiring status that exempts you from any hiring freezes. In addition, NSEP scholars have access to NSEPNET, an Internet-based system that gives NSEP graduates a line on federal jobs and provides résumés to federal managers.

Though the service requirement is something to be taken seriously, NSEP alumna Melanie Gebhart said she would do it again in a minute. Gebhart is completing her chemistry degree at the University of California at San Diego and plans to attend medical school. Like many science students, she had a “one-dimensional approach to success.” But participating in the NSEP program not only broadened her horizons substantially but also allowed her to “develop a fluency in Spanish that will prove invaluable in [her] future career.”

Gebhart studied childhood vaccination programs in Mexico during her fellowship year. “I found my time researching in Mexico one of the most fulfilling and worthwhile decisions of my life,” she said. “I would hope that other science students would take this opportunity not only to enhance their scientific wisdom but also to become more knowledgeable and well-rounded people.”

Joe Alper (ACS ’97), a winner of the ACS Grady–Stack Award, is a science writer in Louisville, CO.
Science librarians are silent but indispensable partners in a broad range of research and development activity. Careers in the field can be very rewarding for individuals who want to use a chemistry degree away from the laboratory bench.

You won’t find their names among the list of authors on a journal article, and they rarely receive one of the “special acknowledgments” doled out at the paper’s end, but they’re the chemist’s silent partners in research and writing. Science librarians can provide the spark of inspiration, supporting data, and special guidance that turn raw research into published results.

Traditionally, science librarians were the “one or two people that held the keys to all the information,” said Kathy Longaberger, science librarian for Goodyear Corporate Research. But with the advent of the Internet and do-it-yourself database searches, librarians are quickly evolving from gatekeepers to guides. While many science librarians still carry out literature and patent searches on behalf of researchers, they are also spending increasing amounts of time managing their libraries’ collections and teaching scientists to use a myriad of new resources.

Careers in many settings
The work of a science librarian may include handling information requests from library patrons, acquiring and cataloging new media for the library, and handling administrative tasks such as contract and budget negotiations. A typical day on the job for Jim Martin at the University of Arizona’s Science and Engineering Library runs the gamut. “It varies from week to week, but I spend time at several meetings related to the library’s management, serve on the reference desk, answer a lot of e-mail, and investigate new databases and other resources,” he noted.

Martin is among the many science librarians who work in an academic setting. But corporations, nonprofit organizations, professional societies, museums, and science centers also employ librarians. The job outlook in each setting differs slightly, according to Don Davis, associate dean of the University of Texas at Austin’s
graduate school of library and information science. While overall employment of librarians has slowed over the past two years in the United States, private corporations and consulting firms are providing new outlets for those who prefer careers outside of academe.

According to the Association of Research Libraries, the 2000–2001 median salary for U.S. university librarians was $50,724. The ACS 2001 Salary Survey lists the mean salary for a chemical information specialist at $66,937. Like most jobs, the salary depends on employer, education, and other skills that a librarian brings to the job, such as Web or database expertise.

Most librarians possess a master’s degree in library science (M.L.S.), and even those who don’t, like Longaberger, think the M.L.S. is essential for today’s job seekers.

“I learned everything on the job, but if we were hiring someone new, we’d ask for the M.L.S.,” she says. “We don’t have as much time to train people. It took one or two years for me to develop the needed skills, but we just don’t have the luxury to do that now.”

Science librarians are a bit more divided on the subject of science training among their colleagues. Martin thinks that a science background, in combination with the M.L.S., is very helpful. He notes that his own B.A. in biology from Reed College, along with coursework in organic chemistry and biochemistry, “gave me a foundation of knowledge that I could build on as I developed a specialty as a science librarian,” he said.

Longaberger agrees to some extent. “It’s very helpful but not necessary. If your main job is to perform searches for people, a science background definitely helps, but many librarians these days are working more on the administrative side, where it’s less important.”

**In the ACS library**

Svetla Baykoucheva (ACS ’97), manager of the library and information center at ACS headquarters in Washington, DC, believes that some science background is essential. “Many scientists are deterred from using the library if the librarian doesn’t speak the same technical language,” she said. Her own credentials include a Ph.D. in microbiology from the Bulgarian Academy of Sciences and an M.S. and a B.S. from the University of Bulgaria.

Baykoucheva came to the librarian’s desk after a full “first life” as an actively publishing researcher in several labs in Europe and the United States. The switch to information sciences felt like a natural next step to her, she said. “I always knew I had it in myself to do this kind of job. I have many interests in writing and literature, so this was a very logical career choice for me.”

Longaberger made a similar midcareer change. She began her career as a Goodyear chemist, analyzing rubber samples and performing other types of corporate research. “The switch to being a librarian was a promotion for me. I enjoyed working in the lab, but I felt that I was lacking in the equipment-fixing skills,” she joked.

Scientists or not, science librarians in the 21st century must be technology professionals. The rise of the Internet, computerized databases, a vast array of electronic media, and other aspects of the wired world have transformed library work over the last two decades. “I was very lucky because I got my M.L.S. degree at the same time that the Internet became a hot topic,” said Baykoucheva. “I just can’t imagine doing without it.”

There’s both fun and frustration in the explosion of library technology, says Martin. “I’m fascinated by all of the incredible features of databases like the Chemical Abstracts Service. I have fun testing things out and trying to think of the best way to demonstrate these resources to others.”

On the other hand, the sheer amount of information and the numerous ways to access it are one of a librarian’s biggest challenges. “It can be very difficult to pick and choose which resources to provide. There are a lot of great tools out there, but they are also very expensive and can be tied to complicated licensing agreements,” said Martin.

Longaberger agrees. “It used to be relatively simple, with one or two vendors for this information, with simple pricing and packaging. Now, with everything going electronic, there are so many different packaging and search options. I spend most of my time reviewing these options and determining the best fit for us.”

Another challenge for corporate librarians like Longaberger is bringing the library’s operations in line with the company’s overall goals. “There are often tighter deadlines, and projects have to fit within certain business plans that take into account the market and our competitors,” she observed.
Keys to a successful career

Some librarians find time to branch out of the library into other projects. Baykoucheva edits and takes photos for the ACS newsletter The Phoenix and continues to write articles on Web searching trends and Internet writing resources, among other topics. Librarians with a variety of interests, from digital photography to desktop publishing, may find themselves more marketable in the long run, she said.

Curiosity—a willingness to explore all options—is a common trait in science librarians, according to Longaberger. “It’s good to be like a detective, you don’t want to quit until you feel you’ve searched every available resource.”

And despite their reliance on technology, good science librarians never lose the human touch, said Martin. “It’s helpful to be friendly and curious. The more you can find out about a scientist’s work, the easier it is to provide him or her with the best resources. I think the real key is to have interest in science, but also a strong commitment to service.”

Becky Ham is a science writer in Washington, DC.

Increasing Diversity in Chemistry: THE SA APPROACH

By Randy Wedin, Ph.D.

SA chapters, like those in Puerto Rico, help carry out ACS’s efforts to promote diversity in the profession of chemistry. Those efforts are critical because diversity enriches the scientific enterprise with new ideas and approaches to research.

Chemists are trained to look at data, reach conclusions, and then take action.

So when ACS leaders look at demographic trends in the American workforce, they realize the profession of chemistry must become more diverse if our science is to survive and thrive.

Consider the data regarding Hispanic chemists. In 2000, people of Hispanic heritage provided 2.6% of the chemistry workforce. While that’s a big improvement over 1.4% in 1990, Hispanics grew from 9% to 12.5% of the U.S. population during those same 10 years. The U.S. Department of Commerce predicts that, by 2035, nearly one in three school-age children will be Hispanic.

Highlighting its importance, 2002 ACS President Eli Pearce (ACS ’49) made “increasing the diversity of the profession of chemistry” one of the major themes of his presidency. “From my students and my own career path,” said Pearce, “I’ve learned that diversity nurtures and invites new approaches, infuses our field with new skills, and keeps chemists on the frontiers of knowledge.”

As ACS seeks out organizations and programs that foster diversity in the chemistry profession, one of the first places they can look is the island of Puerto Rico, where Student Affiliates (SA) chapters are boosting the number of Hispanic students choosing careers in chemistry.

Every year, the Society reviews all SA chapters, now numbering more than 900
nationwide, to identify those deserving special recognition. And every year, SA chapters in Puerto Rico rise to the top. At the awards ceremony at the ACS national meeting in Orlando, for instance, a total of 6 SA chapters from Puerto Rico were among the 70 chapters recognized as “Outstanding” or “Commendable.” The University of Puerto Rico (UPR)–Humacao campus and UPR–Rio Piedras campus received “Outstanding” awards. Receiving “Commendable” awards were Inter American UPR–Metropolitan campus, San Juan; Pontifical Catholic UPR–Ponce; UPR–Cayey campus; and UPR–Mayagüez campus.

While each of these chapters has a thriving program of its own, they also cooperate on large projects. As Ingrid Montes (ACS ’80), chapter adviser at the UPR–Rio Piedras campus, pointed out, “Puerto Rico is a small island, so it is quite easy to join efforts with other SA chapters and the Puerto Rico local section.” Last fall, for National Chemistry Week (NCW) 2001, the local section and five SA chapters joined together to conduct chemical demonstrations, hands-on science activities, public exhibits, and open houses. More than 2000 K–12 students, as well as members of the general community, participated in these activities.

Adopting the NCW theme, “Chemistry and Art,” the SA chapter at the Rio Piedras campus “adopted” a local middle and high school that focuses on the arts.

In addition to the annual NCW celebration, student affiliates at Rio Piedras organize many other activities and programs throughout the year. “We encourage our students to do undergraduate research and participate in internships,” Montes said. “Many student affiliates attend local, regional, and national ACS meetings. The students present posters and improve their communication skills. Technical symposia and eminent scientist lectures introduce students to professional research talks and careers in chemistry. Students also participate in résumé reviews, mock interviews, and career workshops.”


UPR–Rio Piedras also ranks as the number one baccalaureate-origin institution of 1991–1995 for science and engineering doctorate recipients who are Hispanic U.S. citizens.

The data are clear and convincing: Strong and vibrant SA chapters provide a valuable resource in our profession’s campaign for diversity.

Randy Wedin (ACS ’77) is a science writer in Wayzata, MN.
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“Don’t ever try to be a scientist or engineer,” the algebra teacher warned. John Fenn ignored it and headed toward a long, illustrious career in chemistry that included the development of electrospray ionization. And the chemistry is still right for Fenn.

Editor’s note: Chemistry’s Advisory Board picked John Fenn for the ACS Member Spotlight last April. Fenn, they felt, had done important work that deserved wider recognition. Fenn emerged from Chemistry’s product pipeline in September. A month later, of course, the Royal Swedish Academy of Sciences picked Fenn to share the 2002 Nobel Prize in Chemistry. We thought readers might appreciate this rare glimpse of John Fenn as he will never again be known—Before the Prize—and the insightful comments of colleagues like Alan G. Marshall.

You never hear octogenarian John B. Fenn (ACS ’41) badmouthing younger generations.

Fenn, a chemistry research professor at Virginia Commonwealth University (VCU) in Richmond, VA, feels rejuvenated and exhilarated by contacts with students and other young people on campus.

“And as a bonus, they do a lot of my work,” he confesses. “For instance, if I had to depend upon myself to do everything that has to be done by computers these days, I’d never even get booted up.”

Staying active mentally and physically is Fenn’s secret to longevity.

“John Fenn is incapable of growing old,” asserts longtime friend, Dudley R. Herschbach (ACS ’55), Baird Professor of Science at Harvard University.

The sprightly 85-year-old Fenn rides a city bus to campus during the work week and for exercise climbs up and down 18 flights of stairs daily. He used to bicycle to work, but his wife, Freda, blew the whistle after he jumped a light and tangled with a car four years ago.

Fenn currently directs a small research group at VCU that is studying the influence of water on protein folding. “One of the big questions facing biochemistry today is how and why proteins fold the way they do in solution,” he explains.

In his investigations, Fenn, of course, uses electrospray ionization, a technique he came up with in the 1980s for turning biological molecules into ions for analysis using mass spectrometry.

His innovation has become indispensable and is especially popular with the pharmaceutical industry, which uses electrospray ionization as a cutting-edge research tool, especially in the dynamic new field of proteomics.

“Fenn’s done Nobel Prize-caliber work,” says Alan G. Marshall (ACS ’71), a Florida State University professor of chemistry and biochemistry and president-elect of the American Society for Mass Spectrometry (ASMS). “He’s opened the window for looking at all kinds of biologically important molecules that people couldn’t see before. His impact on the chemical pharmaceutical industry has been enormous.”

At an ASMS meeting in June 2002, Fenn was stunned to hear that about two-thirds of the 2000 or so posters and oral presentations involved his electrospray offspring.

“It’s terrible,” he muses. “I can’t keep up with it anymore. I often want to put the genie back in the bottle.”

The science genie has been good to John Bennett Fenn, who during his illustrious career has been a professor at Princeton and Yale and lectured at Harvard. Circling the globe, as a visiting scientist or professor, his talents have been nurtured in England, Italy, Germany, India, Israel, Japan, China, New Zealand, and Australia.
Amazing stuff for a 13-year-old kid whose first-semester algebra exam came back with the red-ink notation from his teacher, “Don’t ever try to be a scientist or engineer.”

The Berea College experience

That red-letter day occurred in 1929, a year after the Fenn family—mother, father, and brother Norman—had moved from Hackensack, NJ, to Berea, KY.

To this day, Fenn feels his math skills are subpar but that didn’t stop him from excelling in chemistry at Berea College.

The impressionable youngster was lured to chemistry by Julian Capps, a close family friend, who taught the subject at the college. Recalls Fenn, “He had a rare sense of humor and an amazing storehouse of knowledge of all kinds, from natural history to soap-making. Any doubts I might have had were swept away in his freshman chemistry course. He made the subject live.”

Fenn feels sorry for today’s first-year chemistry students. “They walk into class and get a thick book, then race through it,” he says. “Too much is covered in too little time. Introductory chemistry courses are crucibles in which interest in the subject is cremated rather than ignited.”

In fact, almost all structured course work turns Fenn off. Like Plato, he believes the best teaching happens during one-on-one conversations in the labs or hallways, or sitting on a log.

“When you talk to John, no question about it, he tells you what he thinks,” says Robert G. Bass (ACS ’57), a VCU chemistry professor and former chair of the department. “He’s set a great example for some of the younger faculty here.”

Delighted with his Berea chemistry degree but facing a tough job market in 1937, Fenn opted for graduate school and was rewarded with a Yale University teaching assistantship that met most of his expenses, but only for the first two years. He solved his looming financial crisis by getting married.

Fenn readily admits that his wife Margaret, who was 10 years older, became his “fellowship” during his third year at Yale, supporting them both on the odd jobs she found.

Skeptical friends gave the marriage a year or so, but it endured and flourished until 1992 when his bride of 53 years was killed in a car crash in New Zealand. “She was then 85,” he reminisces, “but looked and acted 10 years younger than the husband she had snatched from the cradle.”

Fenn’s Yale memories include Nobel Prize winners Linus Pauling and Lars Onsager. He remembers attending lectures on resonance by Pauling and taking Onsager’s two statistical mechanics courses, known then as Norwegian I and II.

“People used to be afraid to give seminars at Yale,” recalls Fenn, “because Lars would ask questions, get up, take the chalk away from the speaker and start working on the board.”

After leaving Yale with a Ph.D. in physical chemistry, he spent the next five years in process development work at the Monsanto and Sharples chemical companies.

Then, Fenn was lured to Richmond by James W. Mullen, II, a Monsanto friend who founded Experiment, Inc., a company specializing in combustion research. Little did he dream, after 7 years with the firm, that 40 years later he would return to Richmond to accept a job at VCU and marry Mullen’s widow, Freda.

Turned off by research at Yale, Fenn thrived on it at Experiment and celebrated his first publication in 1949, a paper on ignition in high-speed flow. Since then, 115 of his papers have appeared in archival journals, and he has received 16 patents.

Project SQUID

Bitten by the research bug and intrigued by returning to academe, Fenn couldn’t resist an opportunity to direct Project SQUID, a Navy program administered by Princeton University to do research in fields relating to jet propulsion such as combustion, fluid flow, and heat transfer. His experience with SQUID from 1952 to 1962 laid the foundation for the work that would lead to electrospray ionization.

Fenn is happy to have created something useful, but he cautions innovators on the need to protect ideas “in the dog-eat-dog competition of today’s high technology.”

“If you’ve got a good idea, at least file a provisional patent application,” he urges. “For $80, it’ll give you a year to talk openly to people who might support your research without the fear that your idea might be stolen.”

Three children, seven grandchildren, and two great-grandchildren have given Fenn plenty of opportunity to give unheeded advice. “Read, get interested in something, and force yourself to stay with it a while,” he advises young people.

Good luck and the ability to write well are things he considers necessary for a successful chemistry career. “Decent writing is the missing ingredient in too many scientific papers,” he says.

Fenn sharpens his vocabulary with The New York Times crossword puzzles, but his real love is poetry, and he has no problem reciting a Shakespeare sonnet or other classics such as A. E. Housman’s A Shropshire Lad.

The legendary chemist’s many fans will be happy to know that even at bedtime, he hasn’t lost his down-to-earth touch or sense of humor. When restless, he puts himself to sleep by mentally reciting long, earthy poems such as The Shooting of Dan McGrew or The Cremation of Sam McGee.

Don Frederick is a science writer in Washington, DC.
The recipe for preparing a chicken dinner once began with, “First, catch one chicken.” That’s not a trivial observation for astrochemists puzzling over the origins of life. Life’s recipe calls for amino acids, nucleic acids, and other fundamental chemical building blocks. First, however, those organic chemicals must form from simpler starting materials. Then, they must evolve into ever more complex structures that ultimately acquire characteristics, like self-replication, that are the hallmarks of life.

Could it all happen within 100 million years—a mere blink of the eye in geologic and evolutionary terms?

Such is the “window” now believed to exist for development of life. Earth itself formed about 4.6 billion years ago. The earliest fossil evidence suggests that primitive organisms existed about 4 billion years ago. That was just 100 million years after the end of a cataclysmic bombardment of meteors that made surface conditions too hostile for life to exist.

While some scientists argue that life itself came from space, statistical calculations suggest that the odds are extremely small. Space, however, probably did jumpstart the process by supplying the chemical building blocks of primitive life.

“One hundred million years just seems a little short to allow for the creation of both the chemicals of life and life itself, but there wasn’t a need for those chemicals to be synthesized here on earth,” said astrophysicist Scott Sandford, of NASA’s Ames Research Center in Moffet Field, CA.

“Instead, those building blocks were probably part of the enormous tonnage of organic chemicals that arrived during the period of heavy bombardment and that continue to arrive from space even today.”

Cosmic dust grains pepper the earth constantly, dumping more than 30 tons of organic material—carbon atoms bonded to hydrogen, oxygen, nitrogen and other carbon atoms—into the upper atmosphere each day. The universe, it seems, is as much a series of petrochemical complexes as it is a
In this famous experiment, Stanley Miller (ACS ‘51) put chemicals believed to be major components of the early atmosphere—methane (CH₄), ammonia (NH₃), hydrogen (H₂), and water (H₂O)—into a closed system. To simulate lightning flashes from storms also believed to be common on the young earth, he ran a continuous electric current through the system. After a few days, amino acids formed in the water.

In 1953, two University of Chicago chemists proposed the first scientific explanation for how the chemicals of life could arise on a planet such as primordial earth. Two years earlier, a new graduate student named Stanley Miller (ACS ’51) heard a lecture by Harold Urey in which the Nobel laureate suggested that the chemicals of life could have arisen on earth through chemical reactions powered by lightning. Intrigued by the idea, Miller volunteered to run the experiment with Urey’s guidance.

At the time, scientists believed that the earth’s early atmosphere was “reducing,” that is, composed of hydrogen-rich chemicals such as methane, ammonia, water, and molecular hydrogen, and devoid of molecular oxygen. Using such a mixture as a primordial atmosphere, Miller set up a closed reaction apparatus in which a flask of boiling water stood in for the earth’s early ocean, and a pair of electrodes provided the lightning. After a few days of lightning strikes, Miller’s ocean had become murky brown, so he stopped the experiment and analyzed the water, finding large amounts of amino acids in the soup. Additional experiments showed that ultra-violet light could replace lightning, which was handy because planetary scientists thought that lightning wasn’t common in the earth’s early days. Further tinkering with the experimental conditions yielded sugars, nucleic acids, and porphyrins—a major component of the oxygen-carrying protein hemoglobin.

One of the biggest surprises was the ease with which the organic soup formed, suggesting that Miller–Urey chemistry could jump-start life on any planet. More recent evidence suggests that the early atmospheres of the inner planets in our solar system, at least, may not have been reducing. “If the early atmosphere wasn’t reducing, and we really don’t think it was, then this chemistry could have never occurred, at least not here on earth,” explained Joseph Nuth, III, (ACS ’75) a chemist at NASA Goddard.

There’s another, more serious problem with Miller–Urey-type experiments, at least as far as the origin of life on earth is concerned. They only generate so-called racemic mixtures of the amino acids. Each amino acid, except for glycine, occurs in two versions that mirror each other’s shape, in the same way that our hands are identical but mirror images of each other. All living creatures on earth use left-handed amino acids to make proteins, but the Miller–Urey experiments produce equal amounts of both forms, a racemic mixture. And while Miller, who went on to a noted career in chemistry at the University of California–San Diego, believes that early life somehow selected one form over the other at some point during evolution, nobody has ever been able to demonstrate how this might have occurred.

Unless amino acids from other sources,
space perhaps, already had that bias. If so, the deck might have been stacked in favor of molecular left-handedness.

All the stuff of life from space
From the earliest days of radioastronomy, astronomers have known that the universe is full of chemicals. At first, the universe’s known chemical compendium consisted of simple atoms and molecules, such as hydrogen and helium, carbon and iron, and aluminum chloride and magnesium oxide. But as astrochemists detected chemicals with more atoms, the list took on a decidedly lopsided look, with molecules containing carbon, hydrogen, oxygen, and nitrogen predominating. And by the time researchers started identifying molecules with seven or more atoms, the list was exclusively organic in nature, just as it is for larger molecules here on earth.

Today, the contents of the cosmic chemical shelf range from simple molecules, such as methanol, up to complex polyaromatic hydrocarbons (PAHs) similar to those found in coal or heavy petroleum. Astronomers identify these molecules based on their ability to absorb infrared background radiation at discrete frequencies. PAHs, for example, account for most of the infrared absorption in what was once known as the “unidentified infrared bands,” a collection of spikes in the infrared spectrum first noted in 1973. Lou Allamandola (ACS ’76) and his colleagues at NASA Ames have spent nearly 20 years pinning down the identity of the PAHs through a combination of laboratory synthesis, theoretical prediction, and interstellar observations.

Meteorites: Treasure troves of astrochemistry
In addition, researchers have isolated a wealth of organic compounds from meteorites, particularly the 4.6 billion-year-old Murchison meteorite that fell in Australia in 1969 and the similarly aged Orgueil meteorite that hit France in 1864. The compounds obtained from meteorites include almost all of the amino acids found in terrestrial life, as well as many more that aren’t found in the biosphere. The meteorites also contained a host of other biological compounds, including ketones, carboxylic acids, amines, amides, and quinones, molecules that store chemical energy and pass it between different chemical reactions. Such energy-transfer molecules are central players in the energy-producing biochemistry necessary for life.

In 2001, researchers expanded the list with the discovery of two additional biomolecules—sugars and pyridine dicarboxylic acids, which are also critical energy-transfer molecules. To find sugars, geochemist George Cooper and his colleagues at NASA Ames used a combination of techniques, including gas chromatography and mass spectroscopy, to analyze water extracts of pristine samples removed from the interior of the Murchison meteorite. The results from these analyses showed clearly that the meteorites contained many different types of sugars and related compounds known as poly-alcohols, or polyols, at about the same concentrations as the amino acids found in these same meteorites. The researchers also found that the relative amounts of heavy and light carbon and hydrogen atoms—the $^{13}\text{C}/^{12}\text{C}$ and deuterium/hydrogen ratios—in the sugar-alcohols (an important subset of polyols) indicated that these molecules came to earth as part of the meteorite and were not contaminants. These ratios are higher in molecules that originated in the interstellar medium than in those made on earth.

Cooper was also part of a team led by Sandra Pizzarello (ACS ’99), a chemist at Arizona State University, that has examined samples from a more recent arrival on earth. On January 18, 2000, at about 8:45 a.m. local time, a large asteroid or comet broke up in the sky over British Columbia and showered some 500 fragments onto Tagish Lake in the northern reaches of the province. The Tagish Lake meteorite fragments are a treasure to astrochemists because many pieces were recovered from a frozen environment just a week later by amateur geologist Jim Brook, who chopped big pieces of ice containing meteorite chunks from the ice, never handled them with bare hands, and kept them frozen until he could turn them over to the proper authorities. “This was a very significant find, certainly the most pristine, and we were quite anxious to look at the organic materials in the meteorite,” said Pizzarello.

The Tagish Lake meteorite, like both Murchison and Orgueil, belongs to a family of ancient meteorites known as carbonaceous chondrites. These primitive meteorites contain significant amounts of organic carbon and are thought to provide a snapshot of what our little corner of the universe was like at the time the sun and solar system were forming. Pizzarello, known for her analyses of amino acids in meteorites, was able to procure a pristine 4.5-gram fragment. Working with numerous colleagues, she was able to characterize the organic content of the Tagish Lake meteorite, though not, said Pizzarello, without a great deal more difficulty than they expected. “The analysis has been a hellish ride,” she observed.

Pizzarello was shocked by her first glance at the data.

“We expected the results from Tagish Lake to look like those from Murchison and Orgueil, but when we looked for amino acids we found almost nothing, and when we looked further for amines and carboxylic acids that are quite abundant in Murchison, we found almost nothing again. I thought this was the biggest letdown of my life,” she said.

But then the pleasant surprises started coming.

“First we found dicarboxylic acids at about the same abundance as we see in Murchison, which is odd because we’ve always thought that the same physical and chemical conditions that generated the amino acids in Murchison would have made the dicarboxylic acids,” explained Pizzarello. “And then we started finding entire new classes of biologically important molecules, such as phenyl dicarboxylic acids and pyridine derivatives such as nicotinic acid.” Carbon isotope analysis confirmed that these molecules formed in space, not on earth.

“This is really quite important,” said
Lunar and Martian meteorites: Scientists think that comet or asteroid impacts blew chunks of rock off the moon (top) and Mars, producing samples of other worlds that are important in astrochemistry’s search for the origins of life. These meteorites are among a trove that scientists like NASA’s Scott Sandford have recovered from Antarctica. The cube represents 1 centimeter.

Che secure that the chemistry of the Tagish Lake meteorite is different from that of Murchison or any of the other meteorites we’ve studied so far, which means that the environments from which the Tagish Lake and these other meteorites formed were different. Our theories of how chemistry took place in meteorites’ parent bodies were too general. We need to do some more thinking.”

Making a chemical stew
In retrospect, Pizzarello acknowledged, perhaps it shouldn’t have been surprising that mixes of organic compounds existed in various interstellar and nebular environments. After all, in earthly laboratories small changes in conditions can alter the outcome of most chemical reactions. So the same should be true in space, where chemistry could be happening in diverse environments. Those include immense dust clouds hundreds of thousands—or even millions—of solar systems in diameter and the immediate vicinity of newly forming stars or planetary bodies.

Nearly all those locales would have energy to drive chemical reactions. On earth, most chemical reactions are powered by heat. Based on the results of laboratory experiments, ultraviolet radiation should serve the same purpose in the cold of space.

In the astrochemistry lab at NASA Ames, for example, Max Bernstein and colleagues have shown that ultraviolet radiation can power a set of chemical reactions with a surprising outcome. Working at temperatures around 15° above absolute zero (–257 °C), Bernstein and his colleagues created an interstellar ice analog from a mixture of water, methanol, ammonia, and carbon monoxide similar to that found in comets. The NASA team then irradiated the mixture with ultraviolet light for two days, which left an oily residue on the surface of the reaction vessel. Assuming that this organic goop would contain the usual mix of water-soluble organic compounds that other researchers have created in similar experiments, the researchers dissolved the residue in water and found something unusual—

droplets formed. Further analysis showed that these droplets were actually tiny circles comprising molecules with a water-soluble head and an oily tail, the same kind of molecules that come together to form cell membranes in all creatures on earth except viruses. In essence, the NASA Ames team had shown that a fundamental structure of life, a membrane, could form from chemicals made in the cold of interstellar space.

“This was a remarkable result,” said Sandford, who worked on the project. “But it’s really just an extension of what we’ve produced in every mixed ice experiment we’ve run that clearly shows that mixtures of simple starting materials can react to make hundreds of new chemicals under the conditions seen in interstellar space.”

Chemistry might also occur independent of light-driven reactions. At NASA Goddard, for example, Hugh Hill and Joe Nuth have been doing chemistry on homemade interstellar dust grains designed to resemble the dust that condenses in the cool atmospheres of old stars. The two chemists make the dust by shooting a cocktail of chemicals through a furnace, where fluffy “astrophysical dust grain analog” rapidly condenses. “Once we had this silicate dust, we wondered if the metal atoms on the surface of these particles could catalyze chemistry, just as metal atoms catalyze chemistry in the lab,” explained Hill.

Several experiments later, with a variety of gaseous mixtures as starting materials, and the answer was a resounding “yes.” “We made amazingly complex mixtures of chemicals, including lots of nitrogen-containing compounds, that in overall terms were quite similar to the complex suite of organics you see in meteorites,” Hill explained. “And since we didn’t have an energy source, the metal atoms on the surface of these particles must have been acting as catalysts.”

The uneven-handedness of life
There seems little doubt that the dust-filled reaches of space can provide an environment ripe for organic chemistry to take place. Evidence from many laboratories and telescopic observations confirms that dust
laden with organics can find its way into comets and other large and small bodies, and that these objects can deliver their chemical loads to developing and established planets. Taken together, these findings provide good reason to think that the chemicals of life could have come from the stars.

But there’s still the issue of handedness. Why did life on earth so overwhelmingly evolve with left-handed rather than right-handed molecules? Living organisms have evolved so that they use only left-handed amino acids when they make proteins, but that’s because nature only makes left-handed amino acids. It’s the classic chicken-and-egg question: Did life evolve to use only left-handed amino acids, and so the right-handed forms gradually faded away, or did life evolve to use left-handed amino acids because those were the more prevalent when life got its start?

If Miller and Urey had been correct, nature would have driven this molecular Darwinism. However, the amino acids in meteorites turn out not to be racemic mixtures. Instead, the left-handed forms predominate—this is known as enantiomeric excess—suggesting that molecules drove nature’s evolution. This evidence comes primarily from work done at Arizona State by Pizzarello and her colleagues and is one of the most important issues when it comes to talking about chemical evolution and the origins of life.

Indeed, how left-handedness came about is one of the great mysteries challenging astrochemists these days. For a few years, it appeared that the natural polarization of ultraviolet light in interstellar space could drive chemistry to favor left-handedness over right-handedness, but recently Pizzarello has found enantiomeric excesses that are much higher than is theoretically possible with polarized light as the only factor. A new possibility is that asymmetry in meteorites came about during water processes in the asteroidal parent body and not in the interstellar cloud. For now, at least, there are indications that space-formed molecules may have tilted the balance at life’s start, but everyone in the field still considers this to be an open question.

Did life on earth get a boost from the stars?

While it’s impossible to say for certain, researchers do feel confident in drawing one conclusion from these and other studies. “The diversity of organic compounds that we find everywhere we look makes it reasonable to assume that if life has developed elsewhere in the universe, it’s likely to be based on pretty much the same biochemistry that has evolved here on earth,” said Sandford.

But Hill cited the stickler: “Creating a prebiotic soup seems fairly easy,” he noted. “But making the leap to life is a huge one.”

Joe Alper (ACS ’97), a winner of the ACS Grady–Stack Award, is a science writer in Louisville, CO.
Fire claims a huge human and economic toll. Yet this ancient enemy generally is becoming less of an everyday threat. Flame retardants illustrate chemistry’s broad contribution and challenge chemists who join the war on fire.

Scenes of the World Trade Center tragedy, wildfires ravaging the western United States last summer, and other disasters have burnt a vivid image of fire into the nation’s collective mindset. Fire does have that ever-present potential for devastation on horrendous scales. It kills, maims, and destroys.

Fire, however, generally is less of an everyday threat than it was years ago. The number of fires and fire deaths, for instance, generally have decreased over the past two decades, according to the National Fire Protection Association in Quincy, MA. Home fire deaths decreased about one-third between 1980 and 2000—from 5,200 to 3,420. U.S. fire departments responded to 1.71 million fires in 2000, a 43% decrease from 1980. Civilian fire deaths in 2000 were 38% lower than in 1980.

Plenty of factors were involved, including wider use of smoke detectors and greater public awareness about fire prevention.

The often-forgotten heroes in the battle against fire are flame retardants. These chemical compounds are applied to or incorporated into everything, from children’s pajamas, to computer monitor cases, to automobile seats, to delay the combustion of flammable products. “We use these compounds to increase the amount of time needed for combustion to occur,” said Eli Pearce (ACS ’49). A noted researcher in the field and professor of chemistry at Polytechnic University in New York, Pearce also served as 2002 ACS president. “We’re trying to prevent the fire.”

The use of flame retardants dates back thousands of years. The ancient Egyptians and Romans used alum to protect wood from fire. Over the centuries, other compounds have been used to make wood and textiles less combustible. But the demand for modern flame retardants began to skyrocket as polyurethane foams and other plastics began to compete with wood, metals, and other traditional materials during the early 1900s. The then-new polymers were inexpensive, lightweight, moldable, and durable. However, they also were more susceptible to burn and evolve toxic gases.

“When a polymer is heated to a certain temperature, it goes through a series of reactions that break it down into volatile components,” Pearce said. “These components feed the fire. We try to prevent the production of these volatiles. Instead of breakdown reactions, some retardants cause a series of reactions that make the polymer more thermally stable. By doing that, you get a charring phenomenon. Charring results in more residue rather
than volatiles. That’s the game flame retardant researchers play. We try to design the molecules or the additive systems to get as much charring residue as possible.”

Thus, the strategy behind flame retardants is not necessarily to save the couch or the computer, but to save lives. Sometimes a slight delay before a fire burns out of control or generates a given amount of toxic gases is enough to make a big difference. “In aircraft, the goal is to increase the number of seconds available for passengers to escape from an airplane,” Pearce added. “Even 10 or 20 seconds more can mean lives saved.”

One 1988 study by the National Bureau of Standards (now the National Institute of Standards and Technology) demonstrated the effectiveness of flame retardants. Researchers compared the fire risks of flame-retarded versus non-flame-retarded materials in five products—a television cabinet, a personal computer housing case, a polyurethane foam-padded upholstered chair, an electrical cable, and an electric circuit board. Each product underwent a series of tests in both its flame-retarded and non-flame-retarded iterations.

The study found that flame retardation lengthened the average escape time by more than 15 times. In addition, in a full room test in which all five products were present, the flame-retarded products prevented the fire from spreading throughout the room. In contrast, fire engulfed the room with non-flame-retarded products in less than two minutes.

**Place and mechanism of action**

Different classes of flame retardants work by different mechanisms. Some work in the vapor phase (in the flame), while others work in the condensed phase (in the pyrolysis zone, below the flame). Some retardants work in both places. For others, scientists still do not fully understand the place and mechanism of action.

One group of retardants undergoes endothermic reactions when heated. For example, aluminum hydroxide takes in heat and gives off water when heated above 220 °C. Both effects help to quench fire. The endothermic reaction reduces the heat available (a condensed-phase effect), and the water dilutes the gases in the flame (a vapor-phase effect).

Halogenated flame retardants also work in the vapor phase, but exactly how they work is under some debate. The commonly held belief is that halogens are good at scavenging free radicals in a flame. “In a flame, the most reactive species tend to be hydrogen atoms and hydroxyl radicals,” said Ed Weil (ACS ’50), a professor in the Polymer Research Institute at Polytech. “There is a branching step in the flame, so these radicals give more radicals. If you can scavenge those radicals, and cause them to recombine or form some sort of less reactive species, you can really slow down flame velocity a great deal.”

While halogens are frequently associated with this mode of action, other effects also may be at work. “It’s not a settled matter,” Weil explained. “There is a school of thought that the heat capacities of these molecules are playing an extremely important role. It is a totally unsettled question, so the theory is not in the best shape.… One can demonstrate each of the functions, but the relative importance of each is quite uncertain due to a lack of quantitative work.” Weil sees this as an area of basic fire research ripe for exploration by young chemists. Pearce cited another: “Right now we use a lot of additive, which changes the property of the host polymer dramatically. If we could use less additive—as would be the case with catalysts—this would be a promising area for future research.”

**Smart polymers**

Another area of current research is the development of smart polymers—compounds that spontaneously convert to a less-flammable form when heated. “It requires a reaction that occurs at elevated temperatures and either cross-links the polymer to form a thermally stable cross-link or form thermally stable ring structures,” Pearce said. “Both improve the whole thermal stability of the system. The net
result is you decrease volatiles and increase char." An example of smart polymers is the aromatic polyamides currently used to protect firefighter uniforms.

Charles Wilkie (ACS ’63), professor of polymer and organic chemistry at Marquette University, and his colleagues are using catalysts in Friedel–Crafts chemistry to cross-link polymers. Catalysts have the potential to be highly efficient flame retardants.

The effect of cross-linking on thermal stability is not as straightforward as it sounds. “If you have a typical thermoplastic, degradation will involve breaking bonds until you end up with fragments small enough to go into the gas phase,” Wilkie said. “It’s intuitive that if you can cross-link a polymer, when you break one bond the fragment will still be attached. You have to specifically attack one other bond to allow one fragment to go away. It seems reasonable that cross-linking will enhance thermal stability.”

However, some cross-linked structures are not more thermally stable than their non-cross-linked forms. “What you are doing is rearranging bonds,” Wilkie said. “You are breaking a bond here and remaking it over there, leaving you with the same number of carbon–carbon bonds, for instance.”

It turns out that aromatic (ring) structures are more thermally stable than aliphatic (chain) structures. “If you can generate something with aromatic cross-links, you are going to enhance stability,” Wilkie explained. “The holy grail of cross-linking is to make something that can make graphite. Graphite is the ultimate char.”

### Nanocomposites

A relatively new area of research into flame retardants is nanocomposites, the dispersion of clay or graphite molecules throughout a polymer. The significance of nanocomposites in terms of fire retardancy is demonstrated by a technique called cone calorimetry, which measures the amount of oxygen required to cause combustion. Wilkie describes it as a “how-big-is-the-fire” measure of the rate of heat release.

“It depends on the specific polymer,” Wilkie said. “But with about 3% clay, the heat release rate decreases 20–60%. This is completely polymer-dependent. With polyamide-6 and styrene, you can get 60%. With polyethylene, you’re lucky to get 25%.”

Along with their reduction of heat release rates, polymer–clay nanocomposites at the low loading cited above do not interfere with the mechanical properties of the original polymers. In fact, the compound can actually gain strength by the addition of clay.

“Nanocomposites probably work by forming a barrier,” Wilkie said. “Strands of clay are stuck throughout the polymer. The polymer volatilizes, leaving clay behind. If you imagine a bunch of clay layers standing up in polymers, when the polymer leaves, the clay layers fall over. If enough fall over, they form a barrier.”

However, the layers of clay aren’t connected, so a force akin to a puff of wind from underneath can blow the clay layers apart, removing the protective barrier. Wilkie speculated on the possibility of developing a glue for the system to keep the layers together.

As promising as nanocomposites’ ability to reduce heat release rates sounds, Wilkie believes that they will never function alone in flame retardation because once ignited, nanocomposite-protected materials burn. “I don’t think we’re going to develop a nanocomposite-only system. It needs synergy, either vapor- or condensed-phase synergy.”

Wilkie and his colleagues are looking for good synergists. “What we’re trying to do is to identify a good conventional-phase retardant to use with nanocomposites. I don’t know how many hundreds of materials are out there.” Testing each candidate is too time-consuming, so they have developed a prototype device to use with high-throughput techniques. It tests nanocomposites and cross-linking strategies (both condensed-phase strategies) with conventional vapor-phase strategies.
PBDE concerns
Despite their success in combating fire, flame retardants are not without drawbacks. In 1999, Swedish researchers reported an exponential rise in levels of common flame retardants called polybrominated diphenyl ethers (PBDEs) in human breast milk between 1972 and 1997. More recent studies indicate that the concentrations are leveling off. Other studies found PBDEs bioaccumulating in fatty tissues of fish, marine mammals, and other top predators. Concerns were heightened by work showing that PBDEs cause neuromuscular and endocrine problems in rats and mice—although at doses 1 million times higher than found in the Swedish women. No good data exist about the toxic effects of PBDEs in humans.

Halogenated compounds also have raised environmental concerns, including stratospheric ozone depletion. Weil stressed that not all halogenated compounds are created equal. “Pentabromodiphenyl ether is pretty much getting phased out. On the other hand, decabromodiphenyl ether seems to have fewer environmental problems, due to its negligible vapor pressure and water solubility. It also has a better toxicological profile. Halogenated compounds are getting over-generalized criticism.”

The European mistrust of “chemicals” was reflected in television set manufacture over the last several years. “Some TV manufacturers decided to save money and make an environmental pitch about using fewer chemicals, and they dropped flame retardants from television cabinets,” Weil said. “The result was a large number of deaths” due to television set fires.

Weighing the potential long-term health and environmental consequences against the immediate protection from fire losses is not simple. “Everything has a risk/benefit analysis,” Pearce said. “There are always trade-offs. Society has to decide that.”

The tricresyl phosphate family
Another class of flame retardants, the phosphates, so far has avoided such health and environmental concerns. Phosphate compounds have been used for decades, dating back to flame retardants added to the nitrocellulose shirt collars that men wore in the 1920s. Today, the tricresyl phosphate family has become widely used in polyvinyl chloride. New phosphate materials are being developed all the time.

“It is generally possible to design phosphate compounds to have low toxicity,” Weil said. “It is possible for that matter to do that with halogen compounds. It is possible to design toxicity out of individual classes of compounds if one studies the structures.” Companies today are eager for new classes of flame retardants that won’t expose them to the public criticism associated with bromine.

Designing new flame retardants isn’t a matter of starting from scratch, Weil emphasized. “One point that I make is that a large part of success in this field is not necessarily making new materials, but by compounding, or combining in the right way. We can take advantage of the interactions between polymer additives and in particular between flame retardants. This is a very productive area, which I guess you could call scientific compounding.”

By careful experimental design and the application of regression analysis to the data, Weil and his colleagues try to use existing materials in better-optimized combinations.

Barbara Maynard is a science writer in Laporte, CO.
Fire retardants are just one beachhead in chemistry’s war on fire. Chemists also are working to develop a better fire suppressant. One current project at the National Institute of Standards and Technology (NIST), for instance, is searching for an alternative to Halon 1301 (CF₃Br) as a fire suppressant on airplanes.

Halogen-based fire suppressants have been used for more than 100 years. “If you go back to the 19th century, the first halon [short for halogenated hydrocarbon] used was carbon tetrachloride,” said Richard Gann (ACS ’69), head of NIST’s Next Generation Fire Suppression Technology Program. It is sponsored by the Department of Defense’s Strategic Environmental Research and Development Program. “Firefighters used grenades—glass containers filled with carbon tetrachloride—that they threw into the fire. The carbon tetrachloride was released and put the fire out. The firemen would celebrate by going to the local pub to toss down a few.”

The celebrations took an unusual turn when the firemen would keel over unconscious in the pub. Later it was discovered that carbon tetrachloride affects the liver and acts synergistically with alcohol. Since then, other toxicity problems were found with carbon tetrachloride, so in the 1940s, the U.S. Army conducted a search for a replacement fire suppressant. Halon 1301 was the “best of the bunch,” Gann said. “It was efficient, stored as a liquid, but when released, it vaporized quickly, so that releasing a small amount will fill a space within a small amount of time.” Halon 1301 was especially useful for extinguishing fires in electrical components and other gear that could be damaged by water.

Then, however, halons (along with chlorofluorocarbons) were implicated in the destruction of the earth’s protective layer of stratospheric ozone. A 1987 international agreement, the Montreal Protocol, mandated a phase-out of halons in developed countries by 2000 and in less-developed countries by 2010. Domestic sales of Halon 1301 ended in 1993.

“So here we are in the early ’90s and there’s research, a frenetic effort to come up with replacements,” Gann said. Finding a substitute fire suppressant for aircraft has been particularly difficult. Aircraft need a lightweight, low-volume fire extinguisher that will work quickly at a range of temperatures. Thus far, nothing else has proven to be as effective and efficient as Halon 1301, but the search continues.

“We had to take a look at the world of chemistry and identify alternatives that looked good,” Gann said. “Because there are so many chemicals, we had to have a set of screening tests, so we developed paper protocols and laboratory screening tests.”

Researchers have to juggle several factors in looking for a replacement fire suppressant. First, it must be efficient at putting out fires, which means, among other things, it must have a fairly low boiling point so that it will vaporize to fill a space rapidly. So far, this has been the downfall of phosphorus compounds, which look good except for their high boiling points.

“We have just done a search of Chemical Abstracts to identify low boiling compounds with bromine, iodine, and phosphorus in them,” Gann said. “We are in the process of sorting through those, so we will pick up any low-boiling phosphorus-containing compounds, if there are any.”

In addition, the compound must not stick around for long. To avoid ozone-depleting effects and any undiscovered negative environmental impacts, candidate fire suppressants must degrade relatively rapidly. Robert Tapscott (ACS ’64) at the University of New Mexico coined the term “tropodegradable” to describe this characteristic.

“One way to get around any future environmental impact is to keep the lifetime low,” Gann said. “For example, bromoalkenes have atmospheric lifetimes of days. Even if they have some atmospheric impact that we don’t know about now, they don’t hang around long enough to be of consequence. We can very much head off future problems.”

Finally, the new fire suppressant should not cause firefighters to keel over while knocking back a pint—or have any other toxic effects on humans, for that matter. As his search for a 1301 replacement continues, Gann has found the breadth of knowledge needed for fire chemistry research to be exciting.

“We need to learn things beyond straight chemistry, such as fluid mechanics and heat transfer. Every fire problem brings in many other disciplines as well. We deal with things here such as burning furniture, so we have to learn about textiles and wood chemistry and polymer physics. There are always new dimensions to fire science—that’s fascinating.”
Illness or injury can be an unexpected part of the equation for chemists attending scientific meetings and other travelers. A little planning can help road scholars prevent many health problems away from home and better cope with others.

Travel often enough, as do many peripatetic chemists who attend conferences and other meetings, and you’re likely to have some kind of health mishap on the road.

Some ailments—especially certain infections—are more apt to occur in developing countries where sanitation is below par. More than one-third of travelers to developing countries and eastern Europe had some kind of illness during their journey, according to one 1997 study. “Traveler’s diarrhea” and respiratory illness were the most common.

But unexpected health problems, including life-threatening emergencies, can occur anywhere.

Illness and injury are more difficult to cope with on the road. Family members often are far away. You’re dealing with unfamiliar doctors and hospitals. Quality-of-care concerns may loom in some countries. A language barrier may hinder even the basic communication needed to describe symptoms. And that health insurance card may be worthless. Fortunately, planning and appropriate precautions can minimize the likelihood of becoming ill or injured and help you deal with health problems that do arise. Planning is especially important for older individuals and those with chronic health problems.

Get a pre-travel “tune-up”

It makes sense to bring your car in for a tune-up before a long road trip. Then why not see the doctor and dentist to make sure your body is road-ready? That’s especially important for international travel to devel-

BY JOAN STEPHENSON, PH.D.
oping countries, which often harbor potential health risks such as malaria, yellow fever, and intestinal bugs.

Ned Heindel (ACS ’59), a widely traveled former ACS president from Lehigh University, noted that local physicians, however competent, may not be fully up to date on current infectious disease risks in remote areas of the world or know what vaccinations are needed. That information may be found on the travel website maintained by the U.S. Centers for Disease Control and Prevention (CDC), which provides specific country-by-country vaccination recommendations and up-to-date information about current disease outbreaks. The site also provides a referral list to travel clinics that can advise clients about appropriate vaccinations and precautions for their destination country.

People planning overseas travel can often find expert advice by getting in touch with infectious-disease specialists at a local hospital, especially one affiliated with a medical school. Those planning travel that may require vaccinations should start the process at least 6–8 weeks before departure, because some vaccines require weeks to provide maximum protection.

Special precautions

People with a chronic medical condition should take special precautions because their risks of having an acute episode of illness are greater. Those with illnesses like diabetes or heart disease should consider wearing a medical ID bracelet. Individuals with a chronic illness also should ask their regular doctor for a photocopy of pertinent medical information to take with them.

Travelers should be sure to bring along an adequate supply of their prescription medications (in the original, labeled containers), and carry them on board rather than in checked baggage. Having copies of the prescriptions (including prescriptions for eyeglasses or contact lenses) can also be helpful, in case your medications or eye-wear are lost or stolen or your trip is unexpectedly extended. Prescriptions should include the generic names of medications, particularly when traveling abroad, since brand names may vary from country to country. In addition to packing prescription medicines, carrying a small kit with some basic medical supplies can be helpful (see “Useful items for a medical travel kit”).

That air up there

A unique combination of environmental conditions inside commercial aircraft can not only leave passengers feeling drained but also pose some potential health problems, especially when combined with the fatigue and disorientation of jet lag. Heindel, for example, now breaks up extremely long air journeys with overnight layovers along the way after he and his wife experienced the unpleasant consequences of an exhausting 25-hour journey from the United States to a conference in Brisbane, Australia.

“When we got off the plane, we felt like death warmed over,” he recalled. The campus infirmary of the university that hosted the conference came to the rescue with antidiarrheal medicine, and Heindel quickly bounced back, though his wife spent nearly a week recovering from a combination of intestinal and respiratory symptoms.

“Even the healthiest person being hurled through that much time and space will arrive disoriented, and if you’re prone to picking up an infection, you’re certainly going to do so in that weakened state,” he said.

One common source of complaints of people who fly is air quality. Passengers typically find themselves enclosed in a crowded, poorly ventilated cabin, breathing recirculated air. According to a December 2001 National Research Council (NRC) report, high levels of ozone, low cabin pressure, and other environmental factors inside commercial planes may pose a health risk for people with such conditions as cardiac or respiratory diseases.

Some researchers have found higher rates of the common cold among people working in buildings that use recirculated air. However, a study published in July 2002 in the Journal of the American Medical Association indicated that passengers flying in planes with recirculated cabin air were...
no more likely to catch a cold than those in planes that circulate only fresh air. About 20% of both groups reported having colds within a week of their flight. It’s the high density of people on a plane that facilitates the spread of germs during a flight, not the aircraft ventilation system, experts in the NRC report concluded.

**How dry I am**

Adding to the discomfort is the dryness of cabin air, which contains a scant 15% humidity at cruising altitudes. To prevent dehydration, travel health experts advise drinking plenty of nonalcoholic, caffeine-free beverages before and during the flight. Contact lens wearers should consider donning glasses during longer flights or liberal use of rewetting drops to keep their contacts moist.

Cabin air can also pose another problem: Lower air pressures translate into less oxygen. Cabin air at cruising altitude contains only about three-quarters of the oxygen found in air at sea level. While this is not a problem for the majority of healthy people, some can develop symptoms of mild altitude sickness, including headache, fatigue, dizziness, shortness of breath, nausea, and malaise. Passengers with lung disease may require supplemental oxygen, which the airline will provide by special arrangement.

**Flying with a cold**

A change in air pressure during flying is the cause of aerotitis, inflammation of the middle ear, the most common medical problem reported by air travelers. This condition is most likely to occur as the plane moves from lower to higher barometric pressure as it descends for landing.

Trouble for air passengers can occur when a cold, a sinus infection, or nasal allergies block the narrow canal between the back of the mouth and the middle ear. Pressure changes in the cabin can create a vacuum in the middle ear that tugs the eardrum inward, causing pain. Sounds also can become muffled, because the distorted eardrum is unable to vibrate properly.

Although it’s best to avoid flying with a cold, allergies, or a sinus infection, sometimes it’s simply unavoidable. Taking a nasal decongestant about one hour before your flight (with additional doses during the flight, as indicated by the package directions) can help alleviate pain during take-off and landing. A decongestant nasal spray also can be helpful.

Yawning, chewing gum, or sucking on a hard candy during take-off and descent can also help unblock ears. If yawning and swallowing don’t work, experts suggest the Valsalva maneuver. This technique involves pinching your nostrils shut, taking a mouthful of air, gently pushing the air into the nose, stopping as soon as your ears pop. It’s important not to use too much force, which could tear the eardrums. If the blockage or ear pain persists, you should seek medical care.

**Economy class syndrome**

People who are immobile for hours on a plane, train, or motor vehicle risk a relatively rare but potentially serious condition called a deep vein thrombosis (DVT), a blood clot deep inside the leg. The condition is known as “economy class syndrome” because cases have occurred in people in the cramped quarters in commercial airline economy seating. If the clot breaks off, it can travel to the lungs and block a blood vessel. The result is pulmonary embolism, which can be fatal.

To reduce DVT risk when flying, flex legs, feet, and toes every half-hour or so and take occasional strolls down the aisle. Those driving long distances should stop frequently and walk around a bit. Movement helps keep blood from pooling in the legs. Drinking plenty of water (and avoiding caffeine and alcohol) prevents dehydration and increases blood volume, which improves circulation. Travelers who develop signs of a DVT—notably swelling, pain or tenderness, and redness, usually affecting only one leg—should seek medical care immediately. Symptoms may not occur until after reaching your destination.
Don’t overdo

After the rigors of getting to the destination, remember that the professional and social demands of conferences can also stress the system.

Attila Pavlath (ACS ’57) said he clocked more than 200,000 miles of travel on official business during his term as ACS president in 2001. At ACS’s 2001 national meeting in Chicago, the press of activities was virtually nonstop. One day, Pavlath recalled, he was whisked from hotel to hotel to convention center to attend and give out awards at three different luncheons on the same afternoon.

Such demands took their toll, and at 1:30 a.m., Pavlath went to the emergency room of a Chicago hospital with chest pain. Fortunately, the doctors ruled out a heart attack or other medical emergency, but the 73-year-old Pavlath said the experience made him more mindful of the stresses one can encounter at conferences. Contributing to the problem is the fact that you eat a lot at meetings while forgoing exercise, said Pavlath, who noted that problems are more likely to arise with age.

Hazards of a movable feast

Fortunately, the remedy for overindulgence is simple: moderation. However, another gastronomical hazard, traveler’s diarrhea, requires more vigilance, especially in developing countries.

Avoiding unsafe drinking water and risky foods is the best strategy for preventing traveler’s diarrhea, as well as such illnesses as cholera, dysentery, typhoid fever, and hepatitis A when visiting countries that have increased risk of such infections. An oft-cited rule of thumb is “Boil it, cook it, peel it, or forget it.”

In countries where drinking water is unsafe, avoid tap water, ice, and iced beverages. Instead, drink carbonated beverages or commercially bottled water from sealed bottles. Bottled carbonated water is safer than bottled uncarbonated water, according to the CDC. Bottled water should also be used when brushing your teeth, and remember to take care not to swallow tap water while showering. If bottled water is not available, tap water should be brought to a rolling boil for 1 minute before drinking it.

It’s also important to pass up food from street vendors, as well as unpasteurized dairy products, raw and uncooked seafood, and raw fruits and vegetables that cannot be peeled. The safest strategy is to eat steaming, hot foods that have been thoroughly cooked. Even better, enlist a local to look after your interests.

“I was blessed with an appointee from the Indian Chemical Society who accompanied me on a lecture trip to India,” said Heindel. His observant companion noticed that a serving of yogurt had a thinner consistency than usual. A trip to the kitchen revealed that the chef had watered it down, making it potentially unsafe for Heindel’s susceptible “American belly.”

If traveler’s diarrhea strikes despite your best efforts, travel experts say it’s important to drink safe, clear fluids (without alcohol or caffeine) to prevent dehydration and eat bland, starchy foods, such as saltine crackers, rice, bread, or bananas. Imodium, taken according to package instructions, can be helpful for mild to moderate diarrhea but shouldn’t be taken for more than 24 hours.
Useful items for a medical travel kit

- Prescription medications (in their original containers).
- Copies of prescriptions in case refills are needed.
- Antidiarrheal medication such as loperamide (brand name Imodium). If your plans include travel to a developing country, you might want to ask your doctor about a prescription for an antibiotic to prevent or treat diarrhea.
- Bismuth subsalicylate (brand name Pepto-Bismol) is good not just for tummy upsets but also for treating diarrhea.
- Decongestants and antihistamines for allergies.
- Medications to treat pain, inflammation, and fever, such as aspirin, acetaminophen (brand name Tylenol, and/or ibuprofen (Advil, Motrin, and others). Remember, acetaminophen relieves pain and fever, but not inflammation.
- Hydrocortisone cream.
- Antibiotic ointment, adhesive bandages.
- A 3-inch Ace bandage for supporting a sprained joint.
- Sunscreen with a sun protective factor of 15 or higher.
- Motion sickness medication, such as dimenhydrinate (brand name Dramamine), and antinausea medication such as promethazine (brand name Phenergan).
- Thermometer.
- Insect repellent that contains DEET in pump spray (available in camping stores).
- Cold and cough medicines, pseudoephedrine tablets (such as Sudafed).
- Acetazolamide (brand name Diamox) to help prevent altitude sickness.
- Contact lens fluids, extra eyeglasses, spare pair of glasses, and copy of prescription.

Seek medical attention if you have severe diarrhea with cramps, nausea, bloody stools, dehydration, or fever and chills.

You also might want to ask your doctor about prescribing an antibiotic to take with you. If you have speaking or other commitments that can’t be broken, ask about the preventive use of antibiotics.

The accidental tourist

Ask the typical traveler about health concerns while traveling abroad, and you’ll probably hear worries about diarrhea, exotic infectious diseases, or a heart attack. Diarrhea is common, and half the deaths among Americans traveling abroad are caused by heart attack, stroke, and other cardiovascular problems. But motor vehicle and other accidents account for another 25% of overseas deaths.

While University of Houston chemist Randy Thummel’s (ACS ’66) encounter with a reckless driver wasn’t fatal, it did send him to a hospital in Dubrovnik in 1979, when he was visiting the then-Communist country of Yugoslavia to attend a conference.

“My leg was broken and so was my hand,” said Thummel, who was struck while crossing the street. “I was in the hospital for the next three weeks and underwent major surgery to have my leg put back together.” After three weeks in the hospital, he flew back to the United States in a full body cast.

Much of Thummel’s experience was unusual, such as being cut off from virtually all contact with people outside the hospital, perhaps due to misplaced concerns about bad publicity. But the cause of his troubles, a motor vehicle accident, remains an all-too-common hazard for travelers.

“In many developing countries, traffic laws are limited or are inadequately enforced,” the World Health Organization warned in one publication. “Travelers, both drivers and pedestrians, should be extremely attentive and careful on the roads.” Thummel endorsed such advice. “I’m much more careful crossing streets now, even to this day, particularly when I’m overseas,” he said.

Getting help

One of the most disconcerting aspects of becoming ill or injured while on the road is not knowing where to go for medical assistance—especially when illness strikes in the middle of the night.

While in Boston for the 1998 ACS meeting, Peter Baine (ACS ’70) of California State University at Long Beach and his wife, Barbara, discovered that a hotel concierge or manager often can suggest good hospitals and physicians.

“At about 2 a.m., Barbara woke me up and said, ’I have to go to the emergency room,’” recalled Baine. Rightly concerned about his wife’s symptoms—severe stomach pain and bloody diarrhea—he consulted with the night manager, who promptly dispatched them by taxi to the nearby Massachusetts General Hospital, one of the nation’s most prestigious medical facilities.

When you are traveling abroad, a concierge or other hotel staff member often can refer guests who become ill or injured to an English-speaking physician or a reputable local hospital. American citizens can also turn to a U.S. embassy or consulate for help in obtaining appropriate medical services and contacting family or friends about the problem. An embassy consular officer can also assist in the transfer of funds from the United States.

Those who travel overseas also might consider becoming a member of the International Association for Medical Assistance to Travelers. Membership in the 40-year-old organization is free, and the group can provide a list of English-speaking physicians in areas you plan to visit.

What about medical insurance?

Checking your medical insurance coverage before you travel can prevent unwelcome surprises. Examine your current policy carefully to see what conditions apply when you are away from home, both within the United States and in a foreign country. Your policy may dictate, for example, that you must contact the insurance carrier to approve treatment before you seek medical assistance. Make sure you
carry proof that you are enrolled in your insurance plan, and if you do receive medical care away from home, get full documentation of care and costs.

Many insurance plans are not valid in foreign countries, and overseas hospitals often require a substantial cash deposit upfront. Furthermore, as the CDC cautioned, very few will pay for medical evacuation to a center in the United States. Depending on the location and the patient’s condition, medical evacuation can cost at least $10,000, and sometimes $50,000 or more.

Travelers should consider purchasing a special medical insurance policy that provides protection against catastrophic expenses, including emergency medical evacuation—especially if they are elderly, have a chronic medical condition, or are journeying to risky areas (such as a malaria zone) or countries where the quality of medical care is questionable. Such policies, which are available through travel agents and some credit card companies, vary widely in cost and breadth of coverage; they can cover specific trips or provide ongoing coverage for a year or more.

Pavlath said that his membership in an air medical transportation program called MEDJET Assistance will enable him to return home or to the medical facility of his choice should illness or injury strike while he’s on the road.

“It’s worth every penny for the peace of mind it provides,” said Pavlath.

Joan Stephenson, Ph.D., is a medical writer in Chicago.

Resources

U.S. Centers for Disease Control and Prevention
www.cdc.gov/travel, 800-311-3435
The CDC can provide current information on health risks and recommended and required vaccines by region or country.

U.S. Department of State
http://travel.state.gov/medical.html
The Department of State provides some useful tips and links to medical information for Americans traveling abroad, including resources for locating a physician overseas and lists of companies that provide travel insurance and medical evacuation plans.

World Health Organization
www.who.int/disease-outbreak-news
The WHO posts information about current disease outbreaks worldwide.

International Association for Medical Assistance to Travelers
www.iamat.org, 716-754-4883
IAMAT can provide a list of local, English-speaking physicians, as well as information on travel and health concerns for various countries.

Medic Alert Foundation International
www.medicalert.org
888-633-4298; 209-668-3333 from outside the U.S.
2323 Colorado Ave., Turlock, CA 95382
This nonprofit organization provides members with an identification tag to alert doctors that the wearer has a chronic illness, such as epilepsy or diabetes, or a drug allergy and provides access to his or her medical records through a 24-hour hotline.

The Pocket Doctor: A Passport to Healthy Travel

How to Stay Healthy & Fit on the Road
Joanne V. Lichten, Ph.D. (2001)
ACROSS
1 Heaviest halogen
5 Disease whose sufferers have St. Vitus as a patron saint
9 Carry a solute across a membrane
11 Calcium, for one
12 Suddenly depart from a heritable type
13 Labyrinth
15 Melanin-deficiency condition
16 Bedroom-dwelling arachnid
19 External: pref.
20 Bihemispherical body
23 It can be treated with isopentyl nitrite
24 Methane, _______, propane, …
27 Class member
28 Not dominant
29 Cuspid
30 Mass of blood outside a vessel

DOWN
1 Disease involving bronchi
2 Inherited characteristic
3 Container on a centrifuge
4 Element whose name is derived from a word for “new”
6 Reflex-testing tool
7 Its atomic number is 44
8 Dander or dust, for example
10 Metal with the highest melting point
14 Toward the front plane of the body
15 tRNA-ending triplet, e.g.
17 _______ acid (vitamin A)
18 Eukaryote kingdom
21 Impulse-conducting cell
22 Family members
25 Essential _______ acid
26 Disease characterized by comedones

Chemistry Brain Teaserphiles!
Send your crossword answers by snail mail to Chemistry, care of ACS, 1155 16th St., NW, Washington, DC 20036, or fax to 202-872-6337. Additional copies of the puzzle can be printed by visiting our website at chemistry.org/Chemistry. The first 10 correct responses will receive an ACS glass beaker mug (for hot and cold beverages). See the solution to last issue’s Chemistry crossword on page 34.
A professor who spent years in industry R&D is always emphasizing the importance of commercial applications of chemistry. We’re learning interesting stuff about intellectual property rights. He’s putting a bonus question about trade secrets on the final exam. “It involves a product on and in the mouths of millions,” he said. “Think phenyls,” he added, when pressed for a clue. We don’t have a clue, Lab Rat. How about you?

—Clue Hunter

Dear Clue Hunter,

Start thinking “phenols,” and you may solve the puzzle. That’s probably what the professor said. An intentional slur of the word to throw students off the track? If so, it’s a good bet the question will involve the famous “Listerine formula case.”

The roots go back to Sir Joseph Lister, the British scientist and surgeon who performed the first antiseptic surgery (with phenol, or carbolic acid) in 1865. In 1879, American Joseph Lawrence formulated the original amber-colored Listerine and named it after Lister. It was actually a disinfectant for surgical procedures, and only later became a mouthwash. Lawrence sold his rights in the invention to Jordan W. Lambert, who in 1884 formed the Lambert Co. to sell Listerine to doctors and hospitals. It later became Warner-Lambert Co., which in 2000 merged with Pfizer, Inc. Lambert agreed to pay Lawrence and his heirs $20 for every gross (12 dozen bottles) of Listerine sold. He later reduced the sum to $6.

By 1956, the payments totaled $22 million, and Warner-Lambert asked a court to terminate the royalty payments because the Listerine formula no longer was a trade secret. The court ruled that a trade secret did not necessarily have to remain secret to justify royalty payments. For details of that interesting decision, and tons of other information about intellectual property rights, check R. Mark Halligan’s wonderful Trade Secrets Homepage (www.execpc.com/~mhallign).

Your professor’s clues fit modern Listerine. The active ingredients include thymol ($C_{10}H_{14}O$), for instance, which is a phenol. Phenols are aromatic alcohols, with a benzene-like aromatic ring bonded to a hydroxyl group. Phenol is both a general name for the group of compounds and the specific name for the simplest member of the group—hydroxybenzene, or carbolic acid.

Those 19th-century patients faced side effects when surgeons doused their skin and dressings with carbolic acid. Phenol’s toxic effects include severe but painless skin burns. But it reduced surgery death rates from infection from about 50% to less than 10%. Listerine avoided carbolic acid’s side effects, which is a major reason why it became so popular as a surgical antiseptic and later a general germ-killer.

“A product on the mouths of millions?” Yes, indeed. On and in those mouths. Listerine Antiseptic Mouth Rinse is among today’s best-selling mouth rinses. Clinical trials have shown that it is effective in combating gum disease, the leading cause of tooth loss in adults. “Off-label” uses also have sprung up. Listerine, for instance, is supposed to be quite the stuff for keeping cut roses looking fresh. Just dip the newly cut stems into Listerine for 30 seconds before placing the flowers in a vase of fresh water.

Your question made Lab Rat marvel at how common phenolic compounds are important both in nature and in the commercial products that your professor mentions. Phenolic compounds occur in almost all foods, for instance. Tyrosine, an amino acid found in most proteins, is a phenol. Epinephrine, or adrenalin, the “flight-or-fight” hormone produced by the adrenal glands, also is a phenol. So are methyl salicylate, which produces the minty flavor of wintergreen, and vanillin, the main flavor in vanilla. Aspirin is acetylsalicylic acid. Check out products that contain pyrocatechol, cresol, eugenol, and hexylresorcinol.

—A.K.A. Muridae
2003 Membership Application

American Chemical Society

Upon approval, please activate my ACS Membership including my subscription for 51 issues (print and online) of Chemical & Engineering News. Also, sign me up for my year of ACS Local Section membership and free Division membership.

☐ Mr.  ☐ Mrs.  ☐ Dr.  ☐ Miss  ☐ Ms.

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<th>LAST NAME</th>
<th>FIRST NAME</th>
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Mailing address for delivery of C&EN and membership material.  ☐ Home  ☐ Work

(please provide your full street address. This full address will enable us to ensure you receive your material in a timely manner.)

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Important Note: You must complete the entire application. Please do not leave out information. Incomplete information will slow down your admissions process.

Membership Categories

Do not send any money now. Upon approval you will be invoiced at the appropriate rate. See dues rates on other side of this form. Please check only one:

☐ Regular Member  ☐ National Affiliate  ☐ Student Member  ☐ Member Reinstatement: Membership Number: ______________________

Academic Training

Name of College or University (including current enrollment)  City and State/Country  Curriculum Major  Title of Degree(s)  Month/Year Received or Expected

A.A., B.S., M.S., Ph.D.

Acs-approved School: Please note: If you have less than a B.S. degree in chemistry, chemical engineering, or a chemistry-centered science but have significant achievement in the chemical sciences, you may be required to fill out a supplementary information form.

Professional Experience (Required)

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Inclusive Dates/employment (Mo./yr.)

% of Time Spent on Chemical Work

Work Functions

Demographic Information (Optional)

We ask you to provide the following voluntary information. The American Chemical Society is eager to support programs that benefit under-represented groups in the chemical sciences, and your responses are helpful to these efforts (and to all facets of our services to all of our members). Individual responses are held in strictest confidence and have no bearing on consideration for membership.

Racial-ethnic origin (please check one only):

☐ White (Caucasian)  ☐ Black or African American  ☐ Hispanic  ☐ Asian  ☐ American Indian or Alaskan Native  ☐ Native Hawaiian or Pacific Islander  ☐ Other ______________________________

Date of Birth: ______________________________  Sex:  ☐ F  ☐ M

This space for use of ADMISSIONS COMMITTEE
**Student Discount:** A member who is a graduate student, majoring in a chemical science or a related academic discipline, shall be entitled to a discount of one-half of the membership dues for full-time graduate work.

**New Graduates:** A person graduating with a bachelor’s degree in a chemical science may apply for membership within one year from the date of graduation to receive a discount of one-half of the membership dues.

**National Affiliation:** National Affiliates pay three-quarters dues.

**Husband/Wife Dues:** If you are the spouse of a member receiving *Chemical & Engineering News*, you may deduct a portion of your dues allotted for *C&EN*. Please request this deduction on your dues bill.

**Member Categories & Dues**

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<tr>
<td>Member</td>
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<td>National Affiliate</td>
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Your membership will begin from the date your membership application is processed and will end one year later. This will be your anniversary date.

*U.S. members: $32.65 allocated to *C&EN*. Non-U.S. Members: $32.65 plus postage allocated

$58 additional postage fee for *C&EN* delivery outside of North America.

**American Chemical Society Divisions**

The first selection is free for first-time members; additional selections will be billed.

My free division selection is _______________________________.

I understand I may also join additional divisions and be billed along with my membership dues. (Check additional selections below.)

- Agricultural and Food Chemistry
- Agrochemicals
- Analytical Chemistry
- Biochemical Technology
- Biological Chemistry
- Business Development and Management
- Carbohydrate Chemistry
- Cellulose, Paper and Textile
- Chemical Education*
- Chemical Health and Safety
- Chemical Information
- Chemical Technicians
- Chemical Toxicology
- Chemistry and the Law
- Colloid and Surface Chemistry
- Computers in Chemistry
- Environmental Chemistry
- Fluorine Chemistry
- Fuel Chemistry
- Geochemistry
- The History of Chemistry
- Industrial and Engineering Chemistry
- Inorganic Chemistry
- Laboratory Automation** (probationary)
- Medicinal Chemistry**
- Nuclear Chemistry and Technology
- Organic Chemistry
- Petroleum Chemistry
- Physical Chemistry
- Polymer Chemistry
- Polymeric Materials: Science and Engineering
- Professional Relations
- Rubber Division
- Small Chemical Businesses
- IUPAC Affiliation $29.00 (U.S. members only). The International Union of Pure and Applied Chemistry (IUPAC) offers individual affiliation to members of national chemical societies. Recognized by all the sciences and by the national level academies of science as the international representative body for chemistry, IUPAC is the authority on chemical nomenclature, terminology, symbols, atomic weights, and related topics. IUPAC Affiliates dues for ACS members residing in the U.S. are $29.00 and include a subscription to *Chemistry International* magazine.

**Nomination**

We nominate this Applicant for membership in the American Chemical Society according to the Constitution and Bylaws.

- Check here and submit your application if you want ACS to assist you in finding nominator(s).

1. ACS Member:

   - SIGNATURE
   - PRINTED NAME
   - MEMBERSHIP #

2. ACS Member:

   - SIGNATURE
   - PRINTED NAME
   - MEMBERSHIP #

**Agreement**

I attest to the accuracy of the information on the application. I agree to restrict for my own personal use all publications to which I subscribe at member rates. I understand that membership dues are payable annually unless my signed resignation is received by the Executive Director of the Society prior to the end of the 12-month period for which dues have been paid.

   - SIGNATURE OF APPLICANT
   - DATE
Chemjobs launches February 10

Chemical & Engineering News Classifieds & Careers Online (Chemjobs) will launch on February 10, 2003. This new one-stop career shop combines the features of JobSpectrum.org—for example, résumé posting—with the C&EN online classified ads to provide career resources for both job-seekers and employers. ACS members will be able to view the most recent C&EN classified ads that have appeared in the print version of the magazine; non-members will be able to view them after two weeks. Chemjobs will be the prime site for quality jobs and quality chemists to find each other. Chemjobs will also have an archive of useful career resource information, as well as articles from C&EN and a direct link to the ACS Department of Career Services. Stay tuned and log on to www.cen-chemjobs.org on February 10.

Post-9/11 immigration questions answered

The new Department of Career Services publication “Under an Immigration Microscope” may prove invaluable to foreign-born chemists trying to decipher new immigration laws and procedures put into place in the wake of the September 11 terrorist attacks.

According to the publication, the major thrust of the immigration changes is that visa applications by all foreign nationals will be subjected to far greater levels of scrutiny than ever before. That analysis is offered by Ethan Bensinger, managing director of the Chicago office of Fragomen, Del Rey, Bernsen & Loewy, the nation’s largest law firm practicing exclusively in the area of global immigration and nationality law for the corporate sector.

Areas that Bensinger discusses include:
- important changes in immigration laws and regulations since September 11,
- major changes facing those with F-1 student visas,
- how INS enforcement has changed,
- how biometrics will be used in visa applications,
- what foreign-born scientists will have to do differently to work in the United States,
- whether it will take longer to apply for a visa,
- the Student and Exchange Visitor Information System,
- ways to expedite the visa process,
- when to hire an attorney, and
- whether the field of chemistry raises a red flag during the visa process.

To download a copy of the article, visit chemistry.org/careers and click on Career Library.

ACS Member Insurance Program introduces new Auto and Homeowners Plus Plan

You could save up to $300 a year on auto insurance with Group Savings Plus from the ACS Member Insurance Program. The Board of Trustees, Group Insurance Plans for ACS Members is pleased to introduce the new Auto and Homeowners Plus Plan. Underwritten by Liberty Mutual, this comprehensive program features auto, home, and other personal insurance (including motorcycles, recreational vehicles, yachts, motorboats, seasonal dwellings, and coverage for valuable possessions). Because you are an ACS member, you are eligible for an exclusive group discount of up to 10% off already competitive rates. Other benefits of this new plan: rates that are guaranteed for 12 months; convenient payment plans, including automatic checking account deduction; 24-hour emergency roadside assistance; and round-the-clock claims service. Find out how much you can save with Group Savings Plus. For an immediate, no-obligation quote, call 800-524-9400 or go to www.libertymutual.com/lm/chemistry.

Professionally, the benefits of ACS membership are obvious: career services, education, and abundant networking opportunities. However, did you know that ACS offers benefits to help you with your personal life? Through the purchasing power of ACS members, the Board of Trustees, Group Insurance Plans for ACS Members endorses a broad spectrum of insurance and retirement plans for its members through the ACS Member Insurance Program. Spouses, children, parents, and even in-laws are eligible for many benefits.

The key to a secure future is a sound financial plan, and that includes building a strong foundation with insurance products and retirement plans. Whether you are single or married, the ACS Member Insurance Program has a plan for you: term life, hospital indemnity, AD&D, disability income, short-term, and catastrophe medical insurance coverage, as well as supplemental retirement plans. And plans like professional liability and long-term care are just as important.

Even if you already have insurance, you may want to consider replacing or supplementing your present coverage. Take a look at what the ACS Member Insurance Program has to offer at chemistry.org/insurance or call us at 800-227-5558, ext. 6038.

Sponsored by the Board of Trustees, Group Insurance Plans for ACS Members—your colleagues working for you! 
Many prestigious Ph.D. programs are highly visible, but how can a student find a master's degree program in chemistry, perhaps with a particular emphasis? Not easily. In response, the ACS Office of Graduate Education is compiling a Registry of Chemistry-Based Master's Degree programs that will enable students to match their interests to specific programs. Every year, more colleges and universities offer new and innovative interdisciplinary programs. These programs include traditional areas, such as analytical, inorganic, organic, biochemical, and physical chemistry, as well as alternative courses of study for full- and part-time students and working professionals. The registry, which seeks to document these programs, is accessible without charge via the ACS website and is maintained and updated by the ACS Office of Graduate Education as a service to students seeking information and to college and university departments with programs of interest. Frequently updated, the database provides information such as overviews and objectives of the different programs, duration of study, admission policies, prerequisites, career opportunities, and contact information—many with direct links to the relevant academic departments and graduate school advisers.

Indeed, the master's degree in the chemical sciences is alive and well; however, the challenge remains to bring greater visibility to master's programs and reach an audience of prospective students and professionals who have varied interests and needs. The ACS Registry of Chemistry-Based Master's Degree Programs continues to expand as the breadth and variety of programs increase and more institutions describe their programs in the registry. Program coordinators are invited to list their programs, simply by visiting the website or by contacting the ACS Office of Graduate Education.

Visit http://center.acs.org/applications/masters_survey/browse.cfm to browse the registry and find out how it works and how to post information about a master's program. For more information about the registry or other graduate education programs, contact the ACS Office of Graduate Education at 202-872-4588 or GradEd@acs.org.

Inside ACS

Regional Industrial Innovation Awards Program

Because the innovations of industry are essential to a healthy economy, ACS Industry Member Programs instituted the Regional Industrial Innovation Awards Program. The awards program was launched at the 1998 Southeast Regional Meeting to recognize individuals and teams for their creative innovations that have resulted in a commercial product or process. The awards highlight the outstanding contributions that the profession of chemistry has given to society, as well as the corporate leadership that encourages the dissemination of knowledge that has facilitated these innovations.

The benefits of this program are twofold. First, honorees gain the well-earned recognition of their peers and co-workers and can take pride in being acknowledged by the chemical profession. Second, each honoree's company has an opportunity to enhance its public image and participate in a professional recognition program that will undoubtedly develop lasting goodwill in the community and higher employee morale within the company. Furthermore, the program offers networking opportunities among ACS staff and governance, area students, and honorees' chief executive officers, chief technical officers, and company staff.

Industry Member Programs hosted the program during seven 2002 regional meetings. We were pleased to honor a total of 42 chemists from such companies as E.I. du Pont de Nemours & Co.; Reheis, Inc.; ExxonMobil Research and Engineering Co.; Abbott Laboratories; Cargill, Inc.; Western Research Institute; Ford Motor Co.; General Motors Research & Development Center; Pennzoil-Quaker State Co.; ABB, Inc.; and Eastman Chemical Co. These professionals' chemical advances serve as a testimony to the valuable role chemists and chemical engineers play in improving our lives.

At this time, we invite you to nominate one or more candidates for the 2003 Regional Industrial Innovation Awards cycle and join us in recognizing outstanding professional chemists from the chemical and allied industries. We are proud to announce that we will be hosting the program during all nine ACS regional meetings. The recipient(s) of this award will be honored during their respective regional meetings with an ACS certificate. In addition, recipients will be invited to present a 20-minute talk on their innovation at a special awards symposium with tabletop displays showcasing their work.

Placing a nomination is easy. Honorees are nominated by their companies and peers in recognition of their creativity and contributions to global welfare. Nominees must be chemists or chemical engineers who are ACS members and who reside in the ACS regional meeting territories. For team nominations, only one person on the team needs to be an ACS member. Non-ACS members who are employed by an ACS Corporation Associates member company also qualify for nomination.

For more information, visit chemistry.org/industry/regionalawards, or...
4th Annual ChemLuminary Awards

The 4th Annual ChemLuminary Awards ceremony was held at the ACS National Meeting in Boston. The awards recognize participants in ACS Local Sections or Divisions whose efforts have helped to achieve excellence. This year’s event, titled “Thanking Our Members for Their Volunteer Efforts,” was held on Tuesday, August 20, at the Boston Park Plaza Hotel. The awards presentation was preceded by a poster session where finalists shared their outstanding activities. During the ceremony, 49 awards were presented to sections, divisions, and one individual. The awards were followed by dessert and dancing.

The number of participating committees and divisions rose from 10 to 13 this year. Presenting awards were the

- Committee on Chemistry and Public Affairs
- Committee on Divisional Activities
- Committee on Economic and Professional Affairs
- Committee on Local Section Activities
- Committee on Membership Affairs
- Committee on Minority Affairs
- Committee on Public Relations and Communications
- Division of Chemical Technicians
- Division of Polymer Chemistry
- National Chemistry Week Task Force
- Society Committee on Education
- Women Chemists Committee
- Younger Chemists Committee

For photos, the program, and a list of 2002 finalists and winners, visit chemistry.org/localsections.

Nominations for 2003 ChemLuminary Awards are submitted by local sections in part IV of their annual reports. Forms became available on chemistry.org on November 1 and are due on February 15, 2003. Next year, the ChemLuminary Awards will be held in New York City on September 9.

National Chemistry Week

National Chemistry Week (NCW) was successfully conducted in the fourth week of October, marking its 15th anniversary with an official change of date. Events were held in Washington, DC, and local sections around the country. Local sections offered hands-on activities and demonstration shows to children of all ages. Some sections, like the Western Michigan Section, sponsored events at local malls that were very well attended. The California Section celebrated on the football field at the UC Berkeley–UCLA football game, with a tribute to Glenn Seaborg that included his son, David. ACS staff members were joined by members of the American Chemistry Council (ACC) and the Chlorine Chemistry Council (CCC) to conduct hands-on activities at the Capital Children’s Museum. Additional volunteers from the Soap and Detergent Association, the Washington Local Section, and Catholic University joined ACS, ACC, and CCC volunteers to conduct an assembly followed by hands-on activities with students at Lucy Moten Elementary School in Southeast DC.

NCW events were covered in many publications, and articles ran all week in various newspapers. Press reports featured NCW demonstration shows, lectures, and activities around the country. ACS Communications helped spread the word about NCW in many ways. A media advisory and four feature stories on the chemistry of keeping clean were prepared and distributed. On Monday of NCW, an audio release went to more than 70 of the largest radio media markets nationwide, and the tentative listenership figures for the release suggest that nearly 5.5 million people were reached. Tuesday of NCW, ACS and ACC sponsored a satellite media tour that was offered to ABC, CBS, NBC, and Fox. Conservative preliminary estimates are that these broadcasts alone were seen by 6 million people.

Outstanding outreach activities don’t have to happen just once a year! The Office of Community Activities has other programs that sections may implement, such as Chemagination, a contest for high school chemistry students; the Chemists in the Library program; and Earth Day activities this spring. For more information, visit chemistry.org/oca.

Inside ACS

2003 ACS ProSpectives

Conferences

Produced by the ACS Membership Division, ACS ProSpectives is a series of small conferences for industry scientists that examine a field’s important topics through presentations by top researchers. The conferences offer major advantages for research scientists employed in industry. The schedule for 2003 conferences is listed on the inside back cover of this issue.

- Session topics concentrate on what industry scientists most need to know.
- Attendees are limited to 200, making it much easier for industry scientists to network with speakers and peers.
• These are the only technical conferences designed in both content and format solely to meet the needs of industry scientists.
• The conferences are a product of ACS—so industry scientists can depend on information to be high in quality and credibility.

For more information, visit www.acsprospectives.org or call 800-227-5558 or 202-872-6286.

ACS Women Chemists Committee Travel Awards 2003
Eli Lilly & Co. is sponsoring a program to provide funding for undergraduate, graduate, and postdoctoral women chemists to travel to scientific meetings in 2003–2004 to present the results of their research. Grants may be applied only for registration, travel, and accommodations and are restricted to meetings within the United States. Grant funds are limited, but some funds are set aside for undergraduates. Only U.S. citizens and permanent residents are eligible. Applications should be limited to one per research group. Awards will be given with preference to the following order: 1) any applicant who will be making her first presentation (regardless of format) at a national or major meeting, and 2) any graduate or postdoctoral applicant who has not presented at a national or major meeting since leaving undergraduate school. Women who have received a prior award under this program are ineligible.

The deadline dates for receipt of applications:
• February 15, 2003 for meetings between July 1 and December 31, 2003
• September 15, 2003 for meetings between January 1 and June 30, 2004

To apply for the award, please submit the following:
• A résumé (include permanent address).
• A completed official application form.
You can get a form from http://membership.acs.org/W/WCC/travap00.pdf.
• An abstract of the work to be presented, using the official meeting abstract form (or a printed copy of an online abstract submission). If the abstract is not on the official meeting abstract form, the reason why must be stated on the application form. You will also need to submit your paper through the meeting registration process independent of this travel award application.
• A letter detailing the reasons why you want this award (both scientific and financial) and specifying whether you have made a previous presentation at a national or major meeting.
• A letter from your adviser confirming your participation in the meeting at which you will be making your presentation, commenting on your technical ability and potential, and listing any other travel support that would be available from the department or research grants.

Awards will be made on the basis of scientific merit and financial need, with the WCC Membership/Awards Subcommittee serving as the selection jury. Through this program, Eli Lilly & Co. continues to increase the participation of women in the chemical sciences.

Please send your application to Cheryl H. Brown, Women Chemists Committee, ACS, 1155 16th St., NW, Washington, DC 20036.

The ACS Women Chemists Committee is pleased to call for applications for the Overcoming Challenges Award

The ACS Women Chemists Committee (WCC) has established an award designed to recognize a woman undergraduate from a two- or four-year institution for her efforts in overcoming hardship to achieve success in chemistry. The award consists of a plaque, $250, and up to $1,000 in travel expenses to the fall ACS national meeting. The recipient will be recognized at the WCC luncheon on Tuesday afternoon at that meeting.

Criteria
• The awardee must be a woman undergraduate currently enrolled in a two-year chemistry-related program or pursuing a major or minor in a four-year chemistry program at a school that does not grant a doctorate in chemistry. The awardee must have completed one semester of college-level chemistry.
• Applicants must demonstrate that they have overcome hardships (economic, personal, or academic) in pursuit of their education in order to be considered for the award.
• The jury will consider four categories: improvement, initiative, successes, and grades from the previous two semesters (not cumulative grade point average).

Award administration
• Nominees must submit a letter requesting the award, one letter of recommendation, and school transcripts. The request should contain the nominee’s name, address, telephone number, and e-mail address and explain the hardships the student has overcome and her current successes.

Submissions should be sent to the Women Chemists Committee, ACS, 1155 16th St., NW, Washington, DC 20036.

Nominations must be received by May 1, 2003. The award will be presented at the fall ACS national meeting in New York at the WCC luncheon on Tuesday, September 9, 2003.

ChemTechLinks
The ACS Education and International Activities Division received a National Science Foundation grant to support and advance chemical technician education in the United States.
Goals of the project:
• build on existing chemistry-based activities at ACS,
• communicate with those involved in related activities at local and national levels, and
• establish a foundation on which new activities that support excellence in two-year college chemistry education can be developed.

Online skill standards database
The updated Voluntary Industry Standards, originally published as Foundations for Excellence in the Chemical Process Industry: Voluntary Industry Standards for Chemical Process Industries Technical Workers (Robert Hofstader & Kenneth Chapman, 1997), have been put into a format that allows chemical industries and nearby chemical technology programs to better match skill needs and curricular development (chemistry.org/vis).

Alliance consultants
A cadre of experts in alliance development has been formed to facilitate the building and nurturing of alliances and partnerships between two-year chemical technician programs and local chemical industries.

Outreach to high school students
Recruitment materials that describe career information and opportunities for chemical technicians are being developed for two-year chemical technology programs to customize and disseminate to local high schools. A video and a brochure will be available for both the chemical laboratory and chemical process technology areas.

Professional development for faculty
Three key areas include the publication of A Guide to Classroom Instruction For Adjunct Faculty; three-day workshops for high school and two-year college faculty, designed to elevate their awareness of careers in chemical technology; and a week-long intensive short course in chemical process technology for two-year college faculty.

ChemTechLinks Clearinghouse
This national clearinghouse serves as a central and comprehensive repository for information that is relevant to chemical technician education (www.ChemTechLinks.org).

For more information, contact
Sam Stevenson (202-872-6108, s_stevenson@acs.org) or Steven Iwanowski (202-872-6124, s_iwanowski@acs.org).

Chemistry in Context captivates chemistry students
CHEMISTRY IN CONTEXT: APPLYING CHEMISTRY TO SOCIETY (CiC) is the new 4th edition of this groundbreaking textbook, which uses Web-based activities, interactive figures, and thought-provoking questions to teach chemistry to nonmajors in a real-world context. According to Conrad Stanitski, the senior author and editor-in-chief, the CiC course, textbook, and Web work teach students how to arrive at informed opinions and that “not all information is created equal.”

Kent Peterson, sponsoring editor at McGraw-Hill (publisher of CiC), calls it the “issues first” approach. The idea is to grab the student’s attention, then introduce the concepts needed to understand the issues. Its success is indisputable: CiC is being used in 548 colleges and universities this year. Topics include “Protecting the Ozone Layer,” “The Chemistry of Global Warming,” “Neutralizing the Threat of Acid Rain,” and “New Energy Sources for the New Century.” Green chemistry principles are also featured.

A new feature is Figures Alive!, a Web-based series of animations and exercises. A figure from each chapter is set up interactively to bring alive the concepts it conveys. CiC author Cathy Middlecamp of the University of Wisconsin–Madison explains the uniqueness of Figures Alive! using the nuclear fission figure as an example.

“What’s new is that it’s been animated in context. We start with a fuel pellet and at the end waste piles up.”

Web work helps students understand context by looking at a variety of sources and applying their chemical knowledge. They are graded on the soundness of their scientific reasoning in drawing their conclusions. Students also benefit from interactive websites, such as CHIME (www.mdlchime.com/chime), where they can see and manipulate molecular models being discussed in class.

Peterson notes that six new experiments have been added to the lab manual. The small- and microscale experiments use common, environmentally friendly materials that minimize waste disposal issues.

The Instructor’s Resource Guide is available on the Web only. Professors who adopt CiC are given a user ID to access the Resource Guide and can either print it from the Web or create customized CiC websites in WECBCT or Blackboard, importing exercises and figures as desired.

Middlecamp sums up her use of CiC this way to her students: “I’m making it easier, and I’m making it harder. It’s easier because you don’t have to do the long, involved math calculations. But I’m making it harder because you have to think about real-world issues. In that sense, it’s much harder.”


Chemistry in Context contributors
The authors of the 4th edition are Conrad L. Stanitski (ACS ’62), editor-in-chief, University of Central Arkansas; Lucy Pryde Eubanks (ACS ’60), Clemson University (SC); Catherine H. Middlecamp (ACS ’78), University of Wisconsin–Madison; and Norbert Pienta (ACS ’74), University of Iowa.

Wilmer J. Stratton (ACS ’57) from Earlham College (IN) is the CiC Lab Manual editor, and Marcia L. Gillette (ACS ’82) from Indiana University at Kokomo is the CiC Instructor’s Resource Guide editor. Chemistry in Context workshops will be held throughout the United States in 2003. For more information, visit the ACS website at chemistry.org/education-curriculum/context.html or contact Marta Gmurczyk, 202-872-4588, m_gmurczyk@acs.org.
Travel awards for chemists with disabilities announced!
The ACS Committee on Chemists with Disabilities has announced a new travel grant program. The program is open to all individuals with disabilities who are graduate students, undergraduate students, or postdoctoral researchers who wish to make presentations at scientific meetings. The intent of the grant is to help defray some of the costs associated with travel and lodging. The goal of the program is to promote presentation of scientific research by individuals with disabilities and provide motivated students with opportunities to build professional relationships through networking. The deadline for applications is March 15, 2003, for meetings scheduled between July 1 and December 31, 2003. For more information, visit http://membership.acs.org/C/CWD/travap or contact Kathleen Thompson at 800-227-5558, ext. 8072.

Good chemistry continues at ACS regional meetings
ACS regional meetings bring chemists together in an intimate setting to offer outstanding technical programming to local audiences through symposia, professional development workshops, and poster sessions; present programs for graduate and undergraduate students; recognize outstanding achievements by chemists in the local area through presentation of industrial and academic awards; provide opportunities for networking and meeting colleagues from your area as well as ACS governance and staff; sponsor programs for high school teachers and students; and help you reap more benefits from your ACS membership.

Plan to participate in 2003! Abstract submission for the spring meetings will open in late January and for the fall meetings in early June. Watch Chemical & Engineering News for more details or visit chemistry.org/meetings/regional/calendar.html for more information on the meetings listed on the inside back cover.

Attention ACS Members
You could be the grand prize winner of an all expense paid trip...

to California (2004 ACS Spring National Meeting) or...
Philadelphia (2004 ACS Fall National Meeting) or...
Washington, DC (ACS Headquarters and the Nation’s Capital)

Enter the 2003 ACS Member-Get-A-Member Campaign Sweepstakes—it’s a snap.
1. Be on the lookout for the 2003 Member-Get-A-Member Kit coming in the mail containing a brochure describing ACS benefits and nomination form ready to complete.
2. Draw up a list of candidates by asking yourself: Who among your colleagues or professional friends would benefit from membership in ACS, but hasn’t, as yet, joined?
3. Invite each individual to apply for membership by completing the form. (You can also use our online Member-Get-A-Member application at chemistry.org/membership.)
4. Sign the form yourself then mail it to ACS.

Enter as many times as you want … your name will be entered in the sweepstakes drawing each and every time one of your candidates is accepted for membership. So, the more members you recruit, the greater your chances of winning.

The grand prize winner will receive free registration to the 2004 Spring or Fall ACS National Meeting, airfare, and hotel accommodations. Or, the winner can choose the vacation in DC; this prize includes air fare, hotel accommodations, and tickets for touring.

With ACS … everyone is a winner …
Three ways to win in 2003 … the ACS Member-Get-A-Member Sweepstakes.
1. A special thank-you gift will be enclosed in your 2003 Member-Get-A-Member Kit … so watch your mail.
2. Your name in C&EN … you will be inducted into the President’s Club and publicly thanked again in the pages of Chemical & Engineering News.
3. Your name in the drawing for the Grand Prize … there is no limit to how many times you can enter. Each time a person that you recommended is accepted for membership, you get another chance to win.

Be a winner … help us find more members like you!
ACS … the professional choice that makes a personal difference.
Mark your calendar!

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<td>226th, Fall, September 7–11, 2003 New York, NY</td>
<td>Polymorphism in Crystals February 23–26 Tampa, FL</td>
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2003 ACS Regional Meetings

| 35th Great Lakes Regional Meeting May 31–June 2 Chicago, IL | Catalysis in Organic Synthesis March 2–5 Cambridge, MA |
| 36th Middle Atlantic Regional Meeting June 8–11 Princeton, NJ | ADMET May 4–7 St. Petersburg, FL |
| 58th Northwest Regional Meeting June 12–14 Bozeman, MT | Combinatorial Chemistry September 21–24 Leesburg, VA |
| 32nd Northeast Regional Meeting June 15–18 Saratoga Springs, NY | Proteomics November 9–12 Leesburg, VA |
| 39th Western Regional Meeting October 15–18 Long Beach, CA | |
| 35th Central Regional Meeting October 19–22 Pittsburgh, PA | |
| 59th Southwest Regional Meeting October 25–28 Oklahoma City, OK | |
| 38th Midwest Regional Meeting November 5–7 Columbia, MO | |
| 55th Southeast Regional Meeting November 20–22 Atlanta, GA | |

For more information, call 800-227-5558, toll-free, or e-mail help@acs.org.
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2 When you receive your renewal reminder…
   Go to chemistry.org.

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4 If you are not a registered user of the ACS website, click on New User and fill out the required information (you’ll need your membership number from your renewal notice). After you have registered, your personal home page will appear, then click on Renew Your ACS Membership Online.

You will automatically receive an e-mail confirming that your renewal has been processed. Your new ACS membership card will be sent to you in the mail.

Remember to watch for your notice in the mail and renew your ACS membership online… it saves time… it saves money!
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