How good is electrospray ionization MS (ESI-MS) at detecting weakly bound complexes? Richard Griffey and colleagues at Ibis Therapeutics report a spectrum of a complex held together by a single hydrogen bond. They also describe the binding stoichiometry for complexes of multiple ligands with RNA and an example where a ligand binds to two different sites. The key is choosing the right conditions for the ESI-MS experiment.

The experiments focus on low-affinity complexes formed with a 27-nucleotide RNA model of the 16S rRNA A-site (16S). As a first step, the researchers adjust the “harshness” of ESI-MS conditions by looking for the spectrum of ammonia-adducted ions of 16S. This spectrum appears by either lowering the capillary–skimmer potential or the desolvation capillary temperature.

Binding of the ligand 2-deoxystreptamine (2-DOS) was the basis of several experiments. In one, dissociation constants for ligand-to-complex ratios ranging from 1:1 to 4:1 were determined. However, the chemistry is even more complex, because 2-DOS binds to two distinct sites on 16S. To investigate the stability of these two forms, the researchers turned to collisionally activated dissociation and MS/MS. By varying the relative dissociation energy, the complex was dissociated into the 1:1 complex and the free 16S and 2-DOS ions.

MS also revealed multiple different ligands concurrently binding 16S. One particularly complex experiment found the mono- and bis-ligand complexes of 2-DOS and 16S, plus a complex with 2-DOS and a diaminotriazole simultaneously bound to 16S. The triazole is believed to be hydrogen bound to the RNA. Finally, this tour de force study reports the relative gas-phase activation energies for the dissociation of a series of ligand–16S complexes. (*J. Am. Chem. Soc.* **2000**, **122**, 9933–9938)

**Dynamics with a tracer**

Here is a handy trick. David Padowitz and Benjamin Messmore of Amherst College investigate exchange between long-chain molecules in solution and those arranged as a surface monolayer. However, they use scanning tunneling microscopy (STM), which is too slow to follow the dynamics of individual molecules. To get around this problem, they introduce a tracer molecule that allows the exchange to be followed by the “slow-moving” STM.

The system under investigation is the C$_{28}$H$_{68}$ molecule $\pi$-tritriacountane, which is adsorbed onto graphite. These molecules move on and off the surface in milliseconds—much faster than the seconds required for an STM image. Instead of looking at individual molecules, the researchers tracked the entire surface. To do that, tracer molecules, which replace a central methylene group in the carbon chain with either a sulfur (thioether) or oxygen (ether), are mixed with the alkane or with each other in a ~1:10 ratio. The mixture co-crystallizes on the graphite surface, and the heteroatom is easily viewed.

The researchers find that the sulfur is particularly easy to track, and they can watch the entire monolayer turn over in a few tens of seconds. The rate of exchange is determined from the data, and the researchers speculate on the mechanism. They also see different dynamics at the domain boundaries. (*J. Phys. Chem. B* **2000**, **43**, 9943–9946)
A rainbow of molecular beacons

With the introduction of “wavelength-shifting” molecular beacons, the future for these fluorescent probes looks especially bright, not to mention colorful. Sanjay Tyagi, Salvatore Marras, and Fred Kramer at the Public Health Research Institute in New York developed the new probes, which emit light at various colors yet are excited by a single, monochromatic light source.

Like traditional molecular beacons, the wavelength-shifting version is a single-stranded, hairpin-shaped oligonucleotide probe that does not emit a signal when the hairpin is closed—that is, when the probe’s fluorophore and quencher are close together. The signal becomes detectable when the hairpin is open, and, thus, the quencher and fluorophore are apart.

However, there are two fluorophores in the new molecular beacons—a “harvester” that absorbs energy from the excitation light and an “emitter” that releases energy as a fluorescent signal. The emitter fluorophore is joined to the 5’-end of the probe by a short spacer sequence, the length of which can be adjusted to optimize the fluorescence resonance energy transfer between the two moieties.

The researchers tested three wavelength-shifting molecular beacons. Each one used fluorescein as the harvester; the emitter was either 6-carboxyrhodamine 6G, tetramethylrhodamine, or Texas red. In all cases, the signal was detected predominantly in the emission range of the emitter, not the harvester. In addition, the researchers note that the new molecular beacons were often brighter than conventional ones, and they attribute that change to more efficient energy absorption. (Nat. Biotechnol. 2000, 18, 1191–1196)

Measuring ligand–receptor forces

Cell–cell adhesion generally depends on specific binding between receptors on the surface of one cell and ligands on the surface of another. The amounts of force needed to break apart these receptor–ligand pairs are typically measured “in bulk” using macroscopic methods or nanoprobe techniques at the single molecule level. To help develop a more complete picture, E. Sackmann and colleagues at the University of California–Los Angeles, the MPI for Biochemistry (Germany), and the Technische Universität München (Germany) describe a middle-ground “mesoscopic” method for measuring ligand–receptor unbinding forces.

In the new method, a “test cell”—in reality, an artificially formed giant vesicle—is immobilized on a substrate via receptor–ligand binding. Then a magnetic bead is attached to the top of the cell, and a vertical force of 0.1–2 pN is generated by pulling on the bead. Reflection interference contrast microscopy monitors the structure, and the magnitude and direction of the forces are determined quantitatively.

The approach allows the measurement of unbinding forces under biologically relevant conditions, the researchers say. Because the cell is large, the “pinning center” holding it to the substrate may be ~1000 Å across and may contain ~100 adhesion-pro-
flame photometry and anion exchange chromatography.

The array used is produced commercially and consists of solid-state microelectrodes screen-printed over a salt-doped hydrogel layer. To give a more comprehensive analysis, the array simultaneously measures levels of Na⁺ and Cl⁻, which are the two most reliable indicators; K⁺, which is often used to confirm the diagnosis; and other parameters, such as Ca²⁺, pH, pO₂, and conductivity. The sample turnaround time was ~1 min, compared with several hours using current analysis techniques.

Cluster analyses of Na⁺, K⁺, and Cl⁻ levels together and the Na⁺ levels alone in 21 samples yielded well-defined clustering of positive (normal) and negative (abnormal) samples. Unfortunately, the clustering for Cl⁻ alone, which is generally regarded as the best single marker for cystic fibrosis, was not as good because of interference from NO₃⁻, which is typically found in the reagent to stimulate sweat.

(Analyst 2000, 125, 2264–2267)

**RESEARCH PROFILES**

**Mercy micropumps**

In the realm where millimeters loom large, familiar forces such as gravity and friction no longer reign. Instead, the key to success is harnessing the lesser-known forces that have supplanted their macroscale oppressors. So when Marc Porter, Jing Ni, Chuan-Jian Zhong, and Shelley Coldiron at Iowa State University and the Ames Laboratory–U.S. Department of Energy wanted to make a miniature pump, they abandoned mechanical methods and turned to surface tension.

Others have used surface tension to pump small volumes of fluids, a concept known as the Marangoni effect. In the earlier work, a surface tension gradient was generated between two electrodes that were positioned on the walls of a channel. For example, water-soluble molecules might be transformed from a surface-inactive state to a surface-active state using electrochemical methods. Controlling this transformation would control the surface pressure in the channel, which would drive the fluid.

The Iowa researchers took a completely different approach, developing an electrochemically actuated mercury pump, which is described in the current issue of *Analytical Chemistry* (pp 103–110). Porter says the pump was inspired by the mercury beating heart, a common laboratory demonstration in which changes in the accumulated charge on the surface of a drop of mercury alter the surface tension. These changes in surface tension, in turn, relax or contract the curvature of the mercury drop. “This

**DNA detects lead**

Decades of genetic research are paying off in unexpected ways. In this case, a deoxyribozyme, which is a catalytically active DNA, is the basis of a selective Pb²⁺ biosensor. According to Yi Lu and Jing Li of the University of Illinois at Urbana–Champaign, this unique sensor boasts a >80-fold preference for Pb²⁺ over other common metal ions and a quantifiable detection range of 10 nM–4 µM. Moreover, this approach suggests that a wealth of new biosensors can be developed, because researchers can fish through vast libraries of random DNA or RNA segments for other recognition elements.

The deoxyribozyme in this biosensor cleaves a single RNA linkage in a DNA substrate when activated by Pb²⁺. To make this work, the 5’-end of the substrate, a DNA/RNA chimera, was labeled with a fluorophore, and the 3’-end of the deoxyribozyme was linked to a quencher. The enzyme and substrate hybridized together, and the fluorescence was quenched; the addition of Pb²⁺ led to the cleavage of the substrate and a ~400% increase in fluorescence intensity. The biosensor retained its selectivity to 500 nM Pb²⁺ in the presence of equal amounts of eight other divalent metal ions and under simulated physiological conditions. (*J. Am. Chem. Soc.* 2000, 122, 10466–10467)
Four-color sequencing is the backbone of every genome project, but most four-color sequencing schemes are only ~90% accurate. So Linda McGown and Hui He at Duke University describe a new alternative in the December 15 issue of *Analytical Chemistry* (pp 5865–5873): a “four-decay” scheme, which relies on frequency-domain fluorescence lifetime detection for multiplexed DNA sequencing.

Four-color fluorescence techniques—in which the four fluorescent tags are identified by their emission spectra—have increased sequencing throughput 4-fold, because they allow all four base reactions to be run simultaneously in a single lane. But there is inevitably emission overlap that produces errors in reading the fluorescence spectrum and, thus, misidentification of bases.

"Four-decay" DNA sequencing
In contrast to color-discrimination sequencing, McGown turned to time-resolved fluorescence, which measures the amount of time it takes the excited dye to return to the ground state and emit a photon. It produces a distinct signature that follows first order kinetics, making it far easier to interpret the data. “In a sense, it’s the difference between a line spectrum and a band spectrum,” says McGown. “Would you rather resolve four lines or four broad spectral peaks?”

Applying the time-resolved method to DNA sequencing “just seemed like a natural,” McGown says. But finding sets of four dyes that could withstand the conditions of the sequencing reactions was challenging because most dyes currently in use have similar lifetimes. “The companies focus on making dyes with different colors rather than different lifetimes,” she explains. McGown finally settled on two sets of dyes—one that is excited at 488 nm and the other at 514 nm.

Once the bands have been separated, McGown’s team uses a continuous laser with a modulated frequency to excite the dyes. The frequency of the emitted photon decreases relative to the frequency of the excitation laser, with longer fluorescent lifetimes leading to a greater shift. Those readouts have yielded an accuracy of 96% for reading DNA fragments ranging from 41 to 220 bases.

The team also used Fourier transform data analysis in an attempt to separate the frequency spectrum into the individual components representing all four dyes. Just as with color detection, there is some spectral overlap because the fragments, especially longer ones, don’t always completely separate on the electropherogram. The researchers achieved 99% accuracy with two dyes and 98.5% with three, but technical limitations prevented them from accomplishing the technique using all four. “It’s due to data analysis and propagation of error,” says McGown. Overcoming this limitation, she adds, “is just a matter of improving the data analysis strategy.”

The successful application of the lifetime-resolved technique with four base pairs wouldn’t just improve accuracy, it should also allow researchers to examine larger fragments, McGown says. That would, in turn, increase accuracy and speed by cutting down on the number of enzymatic digestion steps.

The one disadvantage of the current system is that the lifetime fluorescent measurement attenuates the signal, which hurts the detection limit. The difference “depends on several factors, but . . . could be roughly an order of magnitude,” says McGown. The obvious way to compensate, she explains, is to use more sample, perhaps amplifying it with PCR. “But that can run into problems with sample overloading, so we’re working on improving the detection limits.”

There are still other challenges ahead. “We need a better four-dye system,” says McGown. At 488 nm, the researchers could get four dyes that had good, intense signals and resolvable lifetimes. “The only problem was that one dye is much larger than the others, so we had mobility problems [on the electropherogram],” she explains. “You get [one base] migrating at a different rate.”

Even so, the bottom line is that the system could decrease errors in genome sequencing, especially if the researchers can make improvements in the instrumentation. “[The new method] has a lot of potential to be scaled down into a simpler, dedicated detection instrument,” she explains. “I’d like to improve its accessibility . . . to make it simpler to incorporate into routine methodology.”

–Jim Kling
Chip-based mosaic immunoassays

For immunoassays, the perpetual goal is to increase throughput by reducing the amount of reagent consumed, shortening the incubation time, and performing more assays at once. In the current issue of *Analytical Chemistry* (pp 8–12), Emmanuel Delamarche, André Bernard, and Bruno Michel at IBM’s Zurich Research Laboratory (Switzerland) describe a new method for doing just that. They call their approach microfabricated mosaic (“micromosaic”) immunoassays and report that the assays consume only nanoliter quantities of reagents and perform incubations within a few seconds or minutes.

The works draws upon an ongoing effort, led by Michel, which is centered around microcontact processing to develop microfabricated devices. The researchers abandon microwells, which are traditionally used for immunoassays, in favor of a flat poly(dimethylsiloxane) substrate, onto which they deposit narrow stripes of antigen using a network of microfluidic channels fabricated in silicon. Then, a second network of microchannels, perpendicular to the first, delivers the solutions to be analyzed. (The researchers use simple capillary forces to induce flow in the channels.) Binding the analytes results in a mosaic pattern of tiny squares—similar to the grids of dots seen with DNA microarrays—which can be analyzed with a fluorescence microscope.

Researchers have long recognized the value of such a microarray-type format for immunoassays. However, despite some recent success in this area, protein-based assays have generally been more difficult than DNA-based assays to miniaturize and integrate into smaller, highly sensitive, practical formats, Delamarche says. For example, gridlike patterns of DNA oligonucleotides can be “built” on a surface using photolithography, but the same is not possible for proteins, because they can be composed of hundreds of amino acids. (Antibodies generally have ~1400 amino acids.) In addition, proteins can easily lose their three-dimensional structure when handled under “denaturing” conditions.

The key to making the microfabricated device work was the ability to deposit the proteins with a high resolution, says Bernard. To do this, researchers have used various approaches, including inkjet printing, drop-on-demand techniques, microcontact printing, and soft lithography, which is what the IBM team chose. “What is really pleasing to see,” Delamarche says, “is that soft lithography not only has the potential to help microfabrication, but it can handle fragile proteins and pattern them on a surface.”

In preliminary experiments, the sensitivity and reliability of the new approach compared well with those of traditional immunoassays, the researchers say. In the simple case of two-step assays (antigen–antibody pairs), binding and detection occurred over a concentration range of <1–1000 nM. More sophisticated sandwich-type assays (such as enzyme-linked immunosorbent assays) could also be performed, and in these cases, the signal intensity could be scaled with the amount of analyte present.

Another encouraging finding was that dilute solutions of proteins could be used. Proteins from the solution are deposited onto the surface of the substrate as the solution flows inside the microchannel, Delamarche explains. The challenge is that solutions of proteins are typically dilute, and the volume is typically small—possibly less than a nanoliter, depending on the geometry of the channel. To ensure that enough proteins flow through...
the microchannel to entirely coat the exposed region of the substrate, the researchers place a spongelike flow-promoting pad at the far end of every microchannel. As the dry pad soaks up solution, it helps draw fluid through the channel.

The short coating and binding times seen for this device are a result of the small channel dimensions, which prevent mass transport limitations. “This point is really important, and most people don’t realize it,” Delamarche says. People doing conventional assays in microarrays typically wait 30 min while the proteins slowly diffuse in all directions, including toward the surface, but inside the device’s 10-µm-high microchannels, the diffusion path of the protein from the solution to the surface is considerably smaller. Most of the proteins will diffuse to the surface of the substrate within seconds and adsorb. “By performing both the patterned delivery of antigens and antibodies to a surface using microchannels, we make an important economy of solutions, of proteins, and time,” Delamarche adds.

The researchers note that no blinded experiments were performed (although, in some cases, unexpected cross-reactivity—in which antibodies from one species recognized and bound to antibodies from another species—was observed). The reason, Delamarche explains, is that “we were not comfortable developing this work on unknown ground.” However, now that the preliminary work is finished, the team will start using real-life samples to better evaluate the diagnostic potential of the technique. —Sandra Kataman

### 2000 Eastern Analytical Symposium

**Trace atmospheric gases on a shoestring**

The necessity of cost control in the analytical laboratory is a nagging problem. But Purnendu “Sandy” Dasgupta of Texas Tech University has a solution, at least for measuring some trace atmospheric gases: liquid-core waveguide instruments that smash the usual financial barriers and rival the sensitivity of much more expensive spectroscopic instruments.

If you want to measure H₂S or CO₂ then a variety of systems, some of them disposable, are available from sources as convenient as the local hardware store. But if you want to measure sub-parts-per-billion levels of formaldehyde, ammonia, or less frequently monitored gases, Dasgupta’s fiber-optic threads may be the way to go. The sensors are based on readily available scintillating optical fibers, which are constructed of a fluoropolymer (Anal. Chem. 1999, 71, 1400–1407). When a light-excitation source is applied to the side of the tube, light propagates down its length and can be quantified with a relatively inexpensive photodetector.

The idea came from waveguides that were filled with a special scintillation compound and produced for radiation detection. A radioactive source would excite the fiber, and the resulting count could be taken a safe distance away. Later, the fibers were filled with fluorescent dyes. Cheap to produce, with a long shelf-life, the waveguides made their way to the hobby- and education-centric Edmund Scientific Co. There they languished in the catalog, which described them as having no known practical use.

Dasgupta purchased one and was observing the green glow from its end in his artificially lit laboratory. He then walked down the partially sunlit hallway and out into direct sunlight, all the time watching the green glow intensify. Puzzled that the intensity, but not the color, changed with the excitation light, he consulted a colleague who noted simply that the dye, fluorescein, always grows green. This suggested to Dasgupta that properties of the excitation light would not carry over into the emitted light, eliminating a source of detector interference that plagues conventional methods. He translated this into liquid-filled waveguides. An advantage of this approach is that the reaction is often carried out in the waveguide. This approach sidesteps any loss of luminescence and signal strength on the way to the detector, which may be a significant problem during fast reactions in other instruments. For this reason, faster throughput is also possible with the new sensors.

By selecting from a variety of dyes and prereactions that can take place outside or within the waveguide, different analytes such as ammonia, hydrogen peroxide, and formaldehyde can be detected, and the researchers are now working on detecting hydrogen sulfide and other gases (Anal. Chem. 2000, 72, 5338–5347). After examining several excitation sources, Dasgupta’s favorite was the common, inexpensive, light-emitting diodes (LEDs) found at the local electronics supply store, and with the advent of near-UV and violet diode lasers and LEDs, he suggests that the new approach may really take off.
**NEWS**

**BUSINESS**

**DNA diagnostic business growing**

The molecular and cytogenetic disease-testing procedure market is estimated to be $66.3 million in the year 2000 and exceed $100 million in 2005, according to a new market research report, *The DNA Diagnostic Business*, published in October 2000 by Business Communications Company, Inc. (www.bccresearch.com). Sequencing and PCR techniques remain a large and growing part of the market for genetic disease testing, and new disease-specific sequencing procedures are continually being developed.

In particular, fluorescent in situ hybridization (FISH) cytogenetic genetic disease-testing procedures are growing fast, with an average annual growth rate of 12.3% domestically and 13% internationally. One of the most rapidly expanding cytogenetic areas is Her-2/Neu FISH testing for breast cancer. Considerable investments also are being made in emerging markets, such as newborn screening and preimplantation diagnosis. Among the DNA diagnostic technologies currently experiencing a large growth in research and development are MS and biochips.

In addition to providing market analyses, the report profiles several companies in the DNA diagnostic business, including some instrument companies, and discusses some recent gene and technology patent disputes. A section on single nucleotide polymorphism (SNP) research, including the SNP Consortium and database, is also included.

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**Packard plunges deeper into life sciences**

Right now, the place to be is in the life sciences market. The production of biochip and microarray technology has become a focus for many instrument companies, including Packard BioScience. Each January, membership is rotated as new appointees replace members whose terms have expired. The chair of the ACS Division of Analytical Chemistry serves a 1-year term as ex officio representative of the Division.

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**New Advisory Board and A-Page Advisory Panel members appointed**

Eight new members from government, academia, and industry have been selected to serve 3-year terms on *Analytical Chemistry*'s Editorial Advisory Board. Established in the 1940s, the board is a vital link between the editors and the analytical chemistry community. Each January, membership is rotated as new appointees replace members whose terms have expired. The chair of the ACS
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ular Biophysics in the National Institute of Diabetes and Digestive and Kidney Diseases at the National Institutes of Health, received his B.S. degree from the University of Virginia and his Ph.D. from Brown University. Levin’s research interests include vibrational spectroscopic studies involving lipid–protein interactions and domain structures in biological membranes and the development of IR, Raman, and spectroscopic imaging techniques.

**Victoria McGuffin**, professor at Michigan State University, received her B.A. degree from Eastern Michigan University and her Ph.D. from Indiana University. Her research interests include the theory and practice of capillary LC and CE, the development of novel laser-based spectroscopic detectors, and the use of computer simulation methods in separation science and applied spectroscopy.

**Peter Schoenmakers**, professor at the University of Amsterdam (The Netherlands) and principal research chemist at the Shell Research and Technology Centre in Amsterdam, received his Ph.D. from the Technical University in Delft (The Netherlands). His research interests include separation techniques, systematic optimization strategies, and applications of artificial intelligence.

**Barbara Larsen**, a senior research associate at DuPont, received her Ph.D. from the University of Delaware. Larsen’s research interests include using biological MS for determining the structures of small molecules, identifying protein sequences, and developing new high-throughput screening methods.

**Mark Wightman**, professor at the University of North Carolina–Chapel Hill, received his B.A. from Erskine College and his Ph.D. from the University of North Carolina. His research interests include the development of microsensors and microelectrode-based techniques, and the investigations of neurotransmitters.

**Richard Sacks**, professor at the University of Michigan, received his B.S. degree from the University of Illinois and his Ph.D. from the University of Wisconsin. His research interests include instruments and strategies for high-speed GC, columns with tunable and programmable selectivity, and TOFMS for rapid characterization of organic compounds.

**John Frenz**, director of manufacturing science and technology at Genentech, received his Ph.D. in chemical engineering from Yale University. His research interests include both upstream and downstream production of recombinant protein pharmaceuticals, protein chromatography, process monitoring, and data analysis.

**Bruce Chase**, senior research fellow at DuPont, received his B.S. from Williams College and his Ph.D. from Princeton University. His research interests include IR and Raman vibrational spectroscopy of polymeric systems, and vibrational microscopy and imaging using near-field techniques.

**A-Page Advisory Panel**

Analytical Chemistry has also selected nine new members to serve 3-year terms on its A-Page Advisory Panel.

**Dermont Diamond**, associate director of the National Centre for Sensor Research at Dublin City University (Ireland), received his Ph.D. at Queen’s University Belfast (Ireland). His research interests include the design, characterization, and synthesis of molecular receptors, and the development of rapid, multianalyte sensing systems, which use electrochemical and optical sensor arrays.

**Carol Robinson**, professor and director of MS at the Oxford Centre for Molecular Sciences, received her Ph.D. from the University of Cambridge (U.K.). Her research interests include applying MS to structural biology; investigating the mechanisms of protein folding, misfolding, and disease; and assembling macromolecular complexes.

**Klaus-Dieter Franz**, head of Central Analytical Services of Merck KGaA (Germany), received his Ph.D. from the University of Frankfurt (Germany). His research interests include hyphenated methods, automation, chemometrics, miniaturization, and information technologies in analytical science.

**Hubert Girault**, professor at the
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Ecole Polytechnique Federale de Lausanne (Switzerland), received his Ph.D. from the University of Southampton (England). His research interests include the study of charge-transfer reactions at soft interfaces and the development of microanalytical devices for protein analysis.

Neils Heegaard, head of research and development in the autoimmunology department at the Statens Serum Institut (Denmark), received his M.D. and D.Sc. from the University of Copenhagen (Denmark). His research interests include the development and application of microanalytical methods to study ligand binding to proteins and peptides.

Edgar Arriaga, assistant professor at the University of Minnesota, received his Ph.D. from Dalhousie University (Canada). His research interests include organelle analysis based on CE; micrototal analysis systems; and MS for characterizing subcellular interactions, drug trafficking, and proteomic strategies.

S. Michael Angel, associate professor at the University of South Carolina, received his Ph.D. from North Carolina State University. His research interests include developing methods for remote and in situ chemical analysis using spectroscopic techniques (e.g., Raman and laser-induced breakdown spectroscopy) and fiber-optic chemical sensors.

Robert Dunn, associate professor at the University of Kansas, received his Ph.D. from the University of California–San Diego. His research interests include the study of protein channel dynamics, artificial membrane systems, single molecule spectroscopy, and the development of new microscopy methods.

Rachel Loo, research associate at Pfizer Global, received her B.S. degree from the University of Wisconsin–Madison and her Ph.D. from Cornell University. Her research interests include applying MS to biology, gel electrophoresis, and antibacterial drug discovery.

2001 ACS awards
Several scientists in the analytical chemistry community will receive the 2001 American Chemical Society awards at the 221st National Meeting in San Diego, CA, in the spring.

Robert Biemann, professor at the Massachusetts Institute of Technology, will receive the ACS Award in Analytical Chemistry, sponsored by Fisher Scientific. The award is given in recognition of outstanding contributions to pure or applied analytical chemistry. Biemann is known for his work in four-sector tandem MS, laser desorption MS, and the first GC/MS and computer techniques.

Ernst Bayer, professor at the Universität Tübingen (Germany), will receive the ACS Award in Chromatography, sponsored by Supelco. The award recognizes specific achievements in the field of chromatography. Bayer is known for his work in capillary HPLC, CE, capillary electrophorography, and coupling these techniques online with MS and NMR.

Csaba Horváth, professor at Yale University, will receive the ACS Award in Separations Science and Technology, sponsored by IBC Advanced Technologies and Millipore. The award recognizes outstanding accomplishments in fundamental or applied separation science and technology. Horváth is known for his work in capillary electrophromatography, biopolymer separations, nonlinear chromatography, and high-speed HPLC.

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Helmut Schwarz, professor at the Technische Universität Berlin (Germany), will receive the Frank H. Field and Joe L. Franklin Award for Outstanding Achievement in Mass Spectrometry, sponsored by Bruker Daltonics. Schwarz is known for his work in reaction mechanisms at the molecular level and in the intrinsic properties of elusive species.

William Klemperer, professor at Harvard, will receive the E. Bright Wilson Award in Spectroscopy, sponsored by Rohm and Haas. The award recognizes fundamental and applied contributions in all fields of spectroscopy. Klemperer is known for his work in the geometric and electronic structures of van der Waals molecules and weakly bound complexes and modeling the kinetic behavior of the