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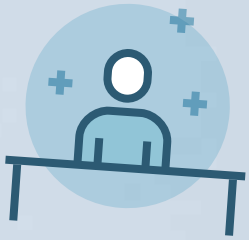

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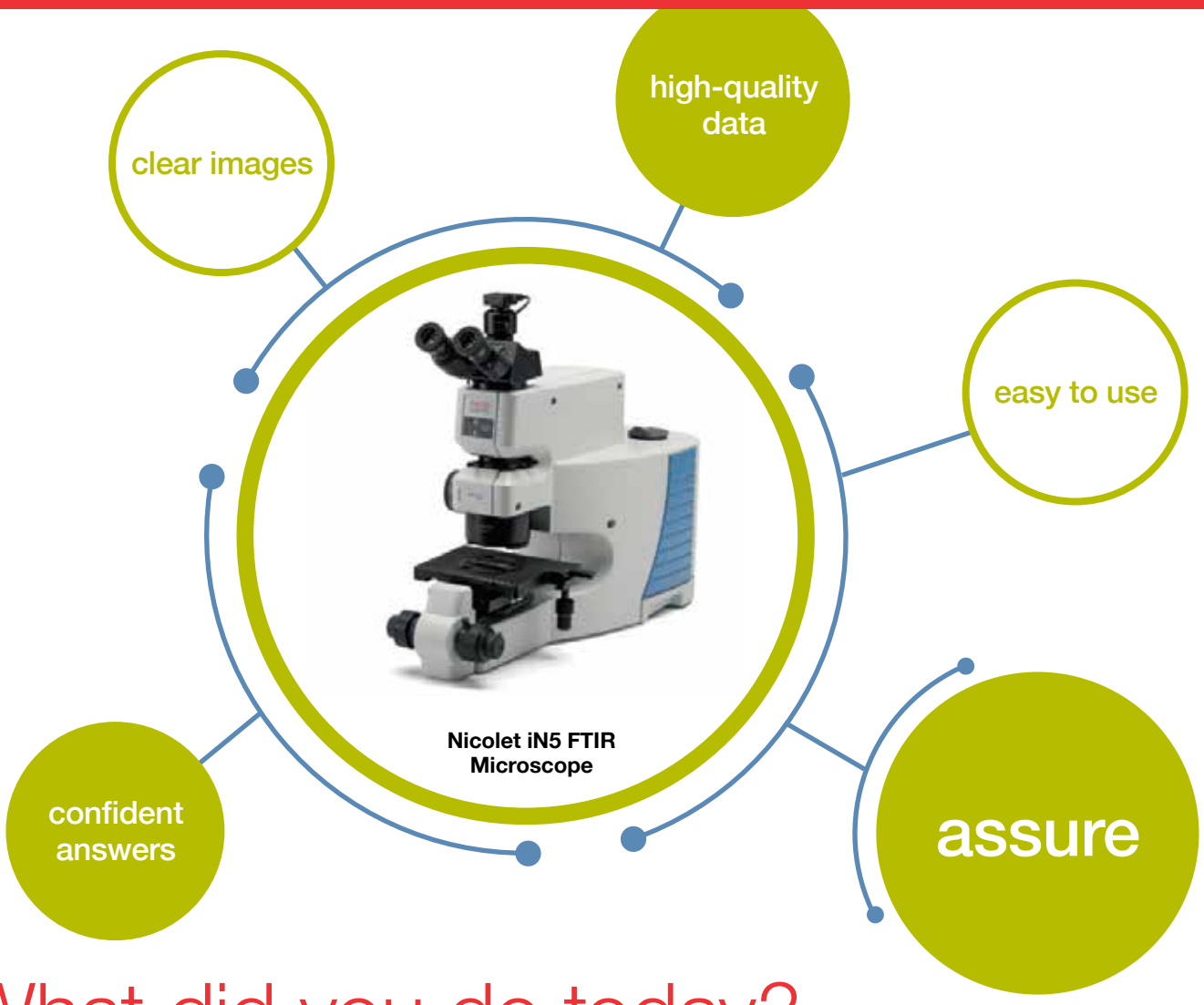

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THANK YOU FOR YOUR FEEDBACK

As we release the results of our 11th Annual Salary & Job Satisfaction Survey in this issue, we wanted to take a moment, to thank you, our readers, for taking the time out of your busy schedules to contribute. Almost 1,000 of you filled out this year's survey, and while the data showed no huge changes over previous years, it still revealed some important trends in the compensation and benefits lab professionals are receiving as well as confirmed trends we identified in previous surveys, including the difficulty of breaking into lab management for younger lab professionals. Turn to page 14 for the full survey results.

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entry level challenges

Earlier this summer, my organization held a company-wide meeting to discuss the latest business initiatives, developments, and company goals. There was also a 'town hall' style event in which everyone was invited to ask questions of upper management. From these questions, employee concerns were identified and grouped on the wall with sticky notes. To no one's surprise, the two largest bunches of sticky notes concerned career growth opportunities and communication.

So it is with this month's cover story, in which managers from a variety of labs share their challenges and best practices for fostering employee satisfaction. The major concern for many involves providing entry-level employees with challenging work and career opportunities, where often technicians/machine operators have replaced researchers on the first step of the career ladder. The greater challenge is that these kinds of entry-level positions—being the most repetitive and labor intensive—are often the least rewarding. Surprisingly, those interviewed did not see the increase in automated lab processes as the problem. "Automation can provide opportunities for staff to work on tasks that are more interesting to them, like method development or lowering detection limits, rather than working on more rote, repetitive tasks," says David Whiting, deputy director, FDEP Laboratory and Water Quality Standards, Division of Environmental Assessment and Restoration, in Tallahassee, Florida.

As for communication, "No matter the policies, compensations, or fringe benefits, no lab can succeed in pleasing its staff without a free flow of communication from managers to employees and among the staff. Only lab managers can instill a proper communication culture," says author Sara Goudarzi.

What we've learned from every salary and employee satisfaction survey we've conducted over the past 11 years is that more than 50 percent of managers are 50 years old and older. While we keep expecting that percentage to change, it hasn't yet. Though one of these days the boomers will either retire, be let go, or leave the lab to try something new. If that's you, Wayne Collins in this month's "Time for a Career Change," has some encouraging news. "After spending years working in a laboratory, many scientists do not realize the unique industry knowledge that they have accumulated or its potential value outside their organization." Turn to page 18 for more.

Finding the funds to do scientific research is a constant struggle for many labs, more so these days with a US president threatening more funding cuts to science. One solution has emerged over the past five years in the form of crowdfunding. Considered more applicable to small business startups, crowdfunding has now found a place in scientific research. "Our mission remains the same, to democratize the research process so that anyone can do science," says Cindy Wu, co-founder of Experiment.com. Turn to page 26 for Part I in a two-part series on this important topic.

This month we feature complementary health and safety articles on creating and managing safety training programs. Vince McLeod in "Combating Hazards," (page 40), and Matt Airhart in "21st-Century Safety Solutions" (page 44), both discuss various methods for reducing injuries and developing a better educated and motivated workforce.

As for technology and industry topics, this month's issue is brimming with both. Page through the issue or go straight to the table of contents to find what's most important to you.

Happy Fall.
Best,

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EMPLOYEE SATISFACTION

BEST PRACTICES FOR KEEPING YOUR STAFF ENGAGED, CHALLENGED, AND HAPPY

by Sara Goudarzi

Several years back, the then-owner of OnSite Environmental Inc., an environmental laboratory located in Redmond, Washington, pulled aside two of his talented and dedicated employees who were engaged in entry-level work. Knowing there were no positions for them to move up to, he good-naturedly relayed to those employees that it wouldn't hurt his feelings if they looked for positions elsewhere.

"He really did it out of the genuine kindness of his heart, letting people know 'Hey, you guys have a lot of potential, and I don't think it's being met here,'" says Karl Hornyik, OnSite's principal.

Within six months, the two employees left their positions at the lab.

"I think we learned something from that, and there was a real loss in that they were both really skilled, very competent, and really good employees, and I think had we been able to offer them even a little bit of something, they could've hung around a bit longer," Hornyik says. "You never know when someone else will leave and a position will open up for somebody."

The ultimate difficulty that Hornyik and many other managers face, both in the laboratory sector and in other industries, is that a significant portion of the entry-level jobs tends to be the least rewarding, partly because those jobs are the most repetitive and often labor intensive. And if there are no positions for those individuals to move up to, those employees end up less than satisfied.

An important part of managerial responsibility, aside from making sure that the lab is running smoothly and jobs are getting done on time and on budget, is to ensure an overall satisfactory work environment. Any good manager knows that when employees are happy, performance goes up, and when performance improves, so does business.

Each manager has to assess what the culture of his or her lab is and how this culture can be improved. In the case of Hornyik, he is keenly aware of ensuring that his employees don't feel trapped in entry-level or tedious jobs and they feel they are improving as professionals.

"So what we try to do is allow our employees to have training opportunities," he says. "Even if they're not a full-time analyst, [we allow them] to be a fill-in person so that they do see that there's sort of a light at the end of the tunnel here, and they're actually able to, even though we may not have a spot for an analyst open for them, train for moving in that direction."

The role of automation

Over the years, many labs have experienced an increase in the automation of tasks. If there were a relationship between increased automation and job satisfaction, one would imagine a decrease in levels of fulfillment among workers.

But in fact, managers are seeing the opposite effect; as repetitive tasks are automated, lab professionals are left to do what machines can't do—think. And once individuals engage in more analyses, as Hornyik noted about his lab, they seem happier at work.

"Our analysts are constantly seeking better, more efficient ways to do their work in order to meet the increasing demand for analytical support from our department programs," says David Whiting, deputy director, FDEP Laboratory and Water Quality Standards, Division of Environmental Assessment and Restoration, in Tallahassee, Florida.

The FDEP provides state agencies a broad range of analytical services, such as analyses of organic pollutants, pesticides and herbicides, algal toxins, and chemical tracers of wastewater.

> "As repetitive tasks are automated, lab professionals are left to do what machines can't do—think."

Whiting does admit that automation has led to decreased staffing in the FDEP's analytical chemistry laboratories, where opportunities to automate have been greatest. But, however, he doesn't believe automation has resulted in a decrease in the skill level or satisfaction of employees who perform significantly more analyses today compared with a decade ago.

"If a new automated process requires [fewer] staff hours to perform the same amount of work, the affected staff are freed up to invest their time and energy [in] other priorities and tasks," Whiting says. "The automation can provide opportunities for staff to work on tasks that are more interesting to them, like method development or lowering detection limits, rather than working on more rote, repetitive tasks."

For example, a recent change in one of the organic chemistry analytical platforms in Whiting's lab significantly reduced the volume of aqueous samples that need to be extracted to achieve the same method's detection levels.

"This," Whiting says, "allowed us to move some of those staff into our nutrients laboratory, which was experiencing a significant increase in analytical demand due to a recent change in our watershed assessment program's monitoring strategy."

In labs such as Hornyik's, automation hasn't increased enough to make an impact, be it a positive or negative one. But in the future, if the tasks that his lab employees perform become more automated, he also believes that it could only have a positive effect on the satisfaction of his staff.

"From my perspective, I think people would appreciate that," he says, "because I don't think it's the repetitive tasks that yield job satisfaction for people. If you free people up to do more types of tests that involve thinking or troubleshooting, then that's kind of what makes people a little more engaged with what they're doing."

"Good communication, both up and down the chain of command, is frequently identified by staff as a significant factor in their job satisfaction."

Money and fringe benefits

While keeping people engaged and challenged is an important part of ensuring they are satisfied in the workplace, other benefits, some of which are more material, will also help people feel appreciated and therefore make their overall lives easier.

The most obvious token is an increase in salary or providing bonuses to those who are excelling in their duties. Providing monetary compensation, however, is often more prevalent in the private sector. For those in academia or federal positions, this type of benefit can be limited.

"I wish I had the resources to reward my talented staff, and this is an area that gives me the most concern and heartburn," says Robert L. Tanguay, principal investigator at the Tanguay Lab at Oregon State University in Corvallis. His lab is a high-throughput zebrafish toxicology laboratory with 25 employees, 10 of whom are students.

"The resources are often not there to provide sufficient raises, as 100 percent of the salaries are derived from federal grants and contracts, which are increasingly competitive," he says. "This is a major threat to academic programs and the research enterprise in general."

Similarly, as a state agency laboratory, FDEP Laboratory and Water Quality Standards is also somewhat limited in providing fringe benefits and promotions as compared with a private-sector laboratory. Therefore, these lab managers have to look for other ways to show their appreciation.

For some, this comes in the form of helping employees with long-term goals.

"We do invest considerable time and effort to train our analysts, and we look for ways to promote them into positions of greater responsibility that will move them forward in their professional development," Whiting says. "Many of our division's senior managers started out as analysts in the FDEP laboratory. Their analytical background serves them well, even as non-laboratorians."

Instead of offering monetary compensation, Tanguay's lab tries to provide incentives, including travel to meetings, awards, and other recognition.

Another benefit that lab managers can provide and control is a pleasant lab atmosphere, be it instilling respect for the team members or providing a relaxed environment. For Hornyik, allowing flexibility has yielded big positive results, especially because lab work in the private sector can vary in intensity during different time periods.

"What we try to do most of all is provide a relaxed work atmosphere," he says. "We're very casual here, and we allow people to, for a large part, set their own hours, and we let people take time off regularly."

"Because it's private, our lab tends to be a lot of feast or famine, so when it gets really busy, sometimes people are working long hours. So we try to employ a very generous policy of letting people have time off when it slows down. So people feel less like they're in the middle, as it were, working constantly."

Communicative atmosphere

No matter the policies, compensations, or fringe benefits, no lab can succeed in pleasing its staff without a free flow of communication from managers to employees and among the staff. Only lab managers can instill a proper communication culture.

"Good communication, both up and down the chain of command, is frequently identified by staff as a significant factor in their job satisfaction," Whiting says. "Good, frequent, sustained communication requires some formal process to be used. I hold weekly meetings with my program administrators, who follow by holding weekly meetings with their laboratory managers, who follow by holding weekly meetings with their analytical staff."

Furthermore, Whiting's division arranges quarterly full-staff meetings to brief staff on issues of significance at the agency, division, and staff levels. They use these quarterly meetings, as well as brown-bag lunches, to have employees provide updates on recent research, study results, or method development. The lab also keeps a suggestion box to allow staff to leave anonymous input for the higher-ups.

Similarly, Tanguay holds weekly staff and research-related meetings to provide transparent interactions. His lab also has an open-door policy for communication in all directions within the group.

"Without a concerted effort, misunderstandings and conflicts can erode morale and reduce productivity and impact," he says.

Last, communication is only as good as those receiving the information and processing it properly. This means that managers should have an acute ear for their staff's needs, because if an issue is being mentioned, it usually proves to be significant.

"I've been a lab manager for over 20 years, now a director, but I'm still actively engaged in the management of the laboratory, and I would say my biggest advice would be to really, genuinely listen to the staff and to ask them what they want," Hornyik says. "Now, you're obviously not going to be able to have staff who get to do all they want, but a little bit of goodwill can go a long way."

Sara Goudarzi *is a freelance writer based in New York City. Her website is www.saragoudarzi.com.*

THE ELEVENTH ANNUAL SALARY & EMPLOYEE SATISFACTION SURVEY

COMPENSATION, EMPLOYER LOYALTY, AND CAREER SATISFACTION REMAIN STEADY

by Pam Ahlberg

This being our 11th Salary and Employee Satisfaction Survey, experience has taught us to expect only very small changes across all survey categories. This year was no exception. Demographic changes and differences in wages, bonuses, and job satisfaction were negligible, which makes even the slightest decrease or increase in percentages all the more meaningful and all the more challenging to interpret. That being said, what we learned from this year's nearly 1,000 laboratory professionals who participated is that, for the most part, they continue to have a strong feeling of satisfaction in their careers.

DEMOGRAPHICS

As in previous years, the demographics of those surveyed changed little. The majority of respondents are spread across various industries, including clinical, academic, and industrial laboratories. Though a significant fluctuation occurred in some industries this year, a 5% increase in academic labs and a 6% decrease in clinical labs over the past year were reported.

TABLE 1: Research Organization

University or college laboratory	27%
Clinical/hospital/medical laboratory	18%
Industrial laboratory	15%
Government laboratory	10%
Independent/private research laboratory	5%
Pharmaceutical laboratory	5%
Biotechnology laboratory	4%
Contract research laboratory	4%
Consultant	2%
Other	10%

GRAPHS: A snapshot of our survey respondents

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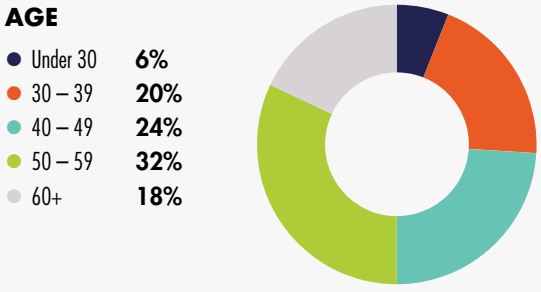

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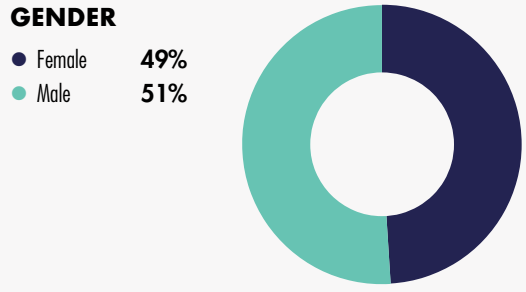

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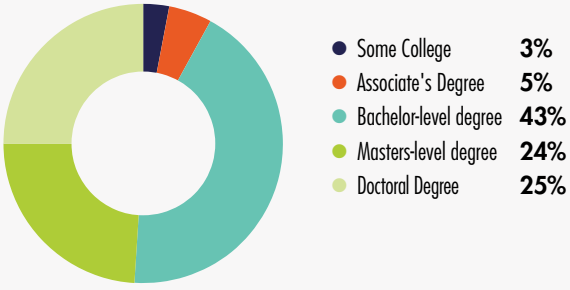

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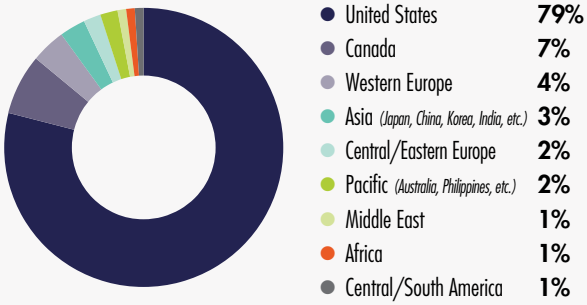

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Of those polled, laboratory management professionals (lab managers, corporate management, technical management, and others) made up 57% of the total respondents. The balance of respondents included technologists, research scientists, chemists, and academics. However, compared with last year, 5% more respondents (12% vs. 7%) identified as research scientists and 9% fewer (57% vs. 68%) as lab managers.

"The bulk of respondents have been in the scientific research field for more than 20 years."

One interesting fact to emerge from this year's survey was that 3% fewer respondents were managing 10 employees or less compared with last year (70% vs. 73%), and 5% fewer were managing less than 25 employees. This seems to suggest that the number of employees in most of these labs has decreased, which would be consistent with the pattern we've seen since beginning this survey. Reduced staff budgets, automation, and more user-friendly instruments might help to explain this trend.

Laboratory professionals are still varied across many domains, with the bulk of respondents found in analytical chemistry, clinical, chemistry, environmental, biology, and microbiology.

TABLE 2: Job Title

Lab manager	57%
Research scientist	12%
Technologist/technician/research assistant	8%
Chemist	5%
Professor	4%
Graduate/postgraduate/PhD student	2%
H&S manager	1%
Biologist	1%
Engineer	1%
Other	9%

TABLE 3: Research Area

Analytical chemistry	18%
Clinical	13%
Chemistry	10%
Environmental	9%
Biology	7%
Microbiology	7%
Molecular biology	6%
Biotechnology	6%
Agri/Food	5%
Drug discovery	3%
Biochemistry	3%
Forensics	2%
Materials science	2%
Neuroscience	2%
Other	7%

EMPLOYER LOYALTY

As we have seen consistently since beginning this survey 11 years ago, the bulk of respondents (47%) have been in the scientific research field for more than 20 years. Those who have worked in this field 10 years or less also remained fairly constant at 26% vs. 23% in 2016.

This year's survey indicated a very minor decrease among those who reported working for the same employer for more than 16 years (30.6% vs. 32.3%). A similarly modest decrease was reported for full-time employment vs. part-time, temporary, or on a contract basis, with 3% fewer telling us they are employed full time (90% vs. 93%). Offsetting that decrease were small increases across the board for those working part-time, temporary, and on a contract basis.

DOLLARS & SENSE

Reviewing the salary data for this year, only minor changes were seen. Salaries have remained fairly consistent, with a few exceptions: the number of workers making $25,000 or less has increased slightly—from 5.8% to 6.2%—while the number of those earning $85,000 increased slightly. Respondents representing the middle of the pay scale remained the same year over year. While the percentage differences at the highest and lowest salary

levels are slight, they are noteworthy when compared with those in the middle that have stayed constant or increased slightly. This echoes last year's takeaway that those beginning their careers in research labs are having a difficult time getting a foothold or earning a respectable salary. One explanation might be that new hires are not required to have the same level of education as in the past—as laboratory tasks become more simplified and automated—and thus cannot command higher starting salaries.

TABLE 4: Yearly Annual Salaries

Less than $25,000	6%
$25,000 - $34,999	5%
$35,000 - $44,999	8%
$45,000 - $54,999	13%
$55,000 - $64,999	13%
$65,000 - $74,999	12%
$75,000 - $84,999	11%
$85,000 - $94,999	8%
$95,000 - $109,999	10%
$110,000 - $124,999	5%
$125,000 - $149,999	5%
More than $150,000	4%

Besides salary, this year's respondents reported minor decreases in nearly every non-salary compensation category. For example, those who were eligible to participate in company bonus programs decreased by 2.4% (38.2% vs. 40.6%). Benefits, including wellness programs and contributions to pensions and retirement accounts; health, dental, and vision insurance; tuition reimbursement; profit sharing; and stock options, were all down a point or two.

EDUCATION MATTERS

Notable this year was the increase in respondents with doctoral degrees (25% vs. 20%), and the decrease in those with bachelor's (43% vs. 46%) and master's degrees (24% vs. 27%). While combined bachelor's- and master's-level respondents make up well over half of all surveyed at 67%, this combined number is down 6 points from last year's 73%. However, similar to last year, those with a bachelor's degree or higher remains the majority at 92%, with those with associate or partial college degrees making up the rest.

TABLE 5: Level of Education

Some college	3%
Associate's degree	5%
Bachelor-level degree	43%
Masters-level degree	24%
Doctoral degree	25%

JOB SATISFACTION

Summarily, employees seem to be very satisfied with their jobs, with 94% once again indicating they will still work in some capacity for their current employer.

"This year's respondents reported minor decreases in nearly every non-salary compensation category."

As for questions regarding training and professional development, there were only a fraction of percentage point differences in answers to questions such as initial job training, ongoing training, and the ability to explore other positions within the company, with one happy exception being that this year, 3.6% more respondents said that their employers provided training or education to help them balance their work and personal life (37.1% vs. 33.5%).

Overall, in most categories, there have been either minor changes or trends consistent with those seen over previous years.

To those who participated in this year's Salary and Employee Satisfaction Survey, thank you. We look forward to revisiting this topic next year and hope for your participation again.

Pam Ahlberg *editor-in-chief for* Lab Manager, *can be reached at pam@labmanager.com or 973-729-6538.*

TIME FOR A CAREER CHANGE?

FOR THE SCIENCE-TRAINED INDIVIDUAL, OPPORTUNITIES ABOUND

by Wayne Collins

Most scientists entering the laboratory aspire to advance either through the technical ranks or up the management ladder, and most fulfill this ambition to at least some degree. But at some point, advancement may be stymied either through attaining the top level in the progression or being blocked by the occupant at the next level. For example, it is difficult to be promoted to lab manager when that job is already filled by a person who intends to remain there for years to come. In other cases, the job may become routine to the point of being boring or, worse yet, may be eliminated during downsizing. This leads us to ask: What are the alternatives for those ambitious individuals who are blocked for promotion, those talented individuals whose job has lost its challenge, or those poor souls who have lost their job? When contemplating a job change, the natural tendency is to look for positions in a similar laboratory where experience may be an asset, but the greater opportunity might lie in expanding the possibilities.

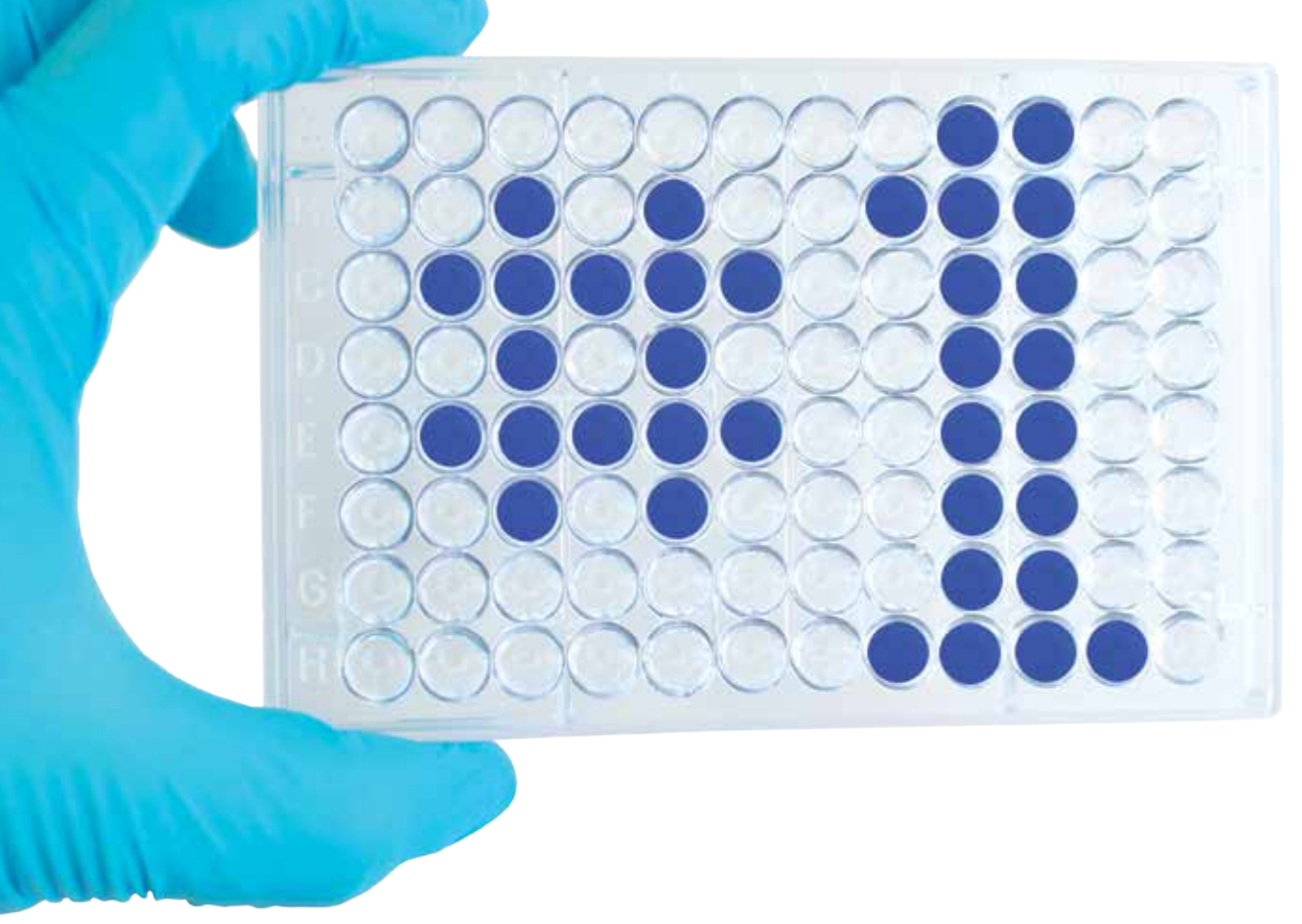
> "It is advantageous to select a management champion who has connections with other managers throughout the organization."

In exploring career options, it is first instructive to examine the skills that are typically possessed by science-trained people who have succeeded in the laboratory. Foremost, success in the lab requires excellent quantitative skills with a fondness for numerical precision. Attention to detail and sharp deductive reasoning abilities are common traits, as are both the willingness and desire to take on difficult assignments—after all, pursuing a science degree is not the easiest path through a university. Lab workers are generally very seasoned in the use of technology, so they are adept at quickly mastering new applications. These are skills that are widely valued in a variety of businesses.

It is also helpful to recognize possible limitations that might hinder aspirations for entry into another field. The stereotypical left brain–driven personality of most scientists may cause them to be typecast and pigeonholed into a narrow range of options by other business disciplines. Some of the things that make one successful in the lab may be interpreted as obstinacy or timidity by nonscientists. For example, the tendency to rely on data before making decisions may give the impression of stalling or unwillingness to act to those in sales, marketing, or other parts of the organization that routinely act on fragmented information. Scientific communication also follows a different standard than most other types. The logical flow of following data to a conclusion might seem tedious to businesspeople who rely on a more subjective approach. So it might be advantageous to consciously work on changing these lab habits when contemplating a move to a new, less quantitative field.

After assessing skills and limitations, one can make a plan to showcase talents for a prospective position and address any potential misperceptions about the ability to perform. When possible, it is advantageous to select a management champion who has connections with other managers throughout the organization or externally to help sell qualifications. Above all, it is important to be practical and realistic in setting aspirations as to what can be achieved. Patience is also a virtue, since achieving the goal may require incremental steps rather than a leap. Now, let's look at a few alternative career moves.

The financial industry welcomes science-trained individuals who are willing to use their analytical skills in assessing potential profitability of companies or in building mathematical predictive models to guide investments. These jobs tend to be high stress, require long working hours in return for high financial reward, and are typically located in the major financial centers. Science training also translates well to the internal financial analysis required within larger companies typically using spreadsheets, specialized software, or enterprise computer systems such as SAP. The goal for these analysts is to shed light on the company business in a way that allows management



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to understand the profitability of each segment and to identify opportunities for investment to grow the business. In one company, an internal transfer from the lab to the financial department was accomplished by the lab manager persuading the chief financial officer to accept one of his best chemists for an open financial analyst position. The move worked extremely well, with the hiring manager later commenting that his biggest challenge was to keep his new employee busy since he completed projects so much more quickly and in greater depth than expected. The chemist found new career opportunities with the move and was easily able to understand the mathematical manipulations required to perform the job, and was even able to automate much of the analysis with spreadsheet routines.

"Many scientists do not realize the unique industry knowledge that they have accumulated or its potential value outside their organization."

The marketing and service departments of companies selling laboratory instruments or supplies are more familiar opportunities for those with lab experience. These jobs range from developing analytical applications using the company's instruments to providing the "voice of the customer" for marketing collateral and advertising campaigns. By relying on actual experience in the lab, a scientist can explain to the creative agency the customer benefit provided by the product. For example, the product manager might stress the design characteristics of the instrument such as precision and degree of control while the marketing manager explains how the lab that buys the instrument will use it to make money for the organization or further its research. These jobs may be broadly defined so that the marketing manager becomes involved in many aspects of the business, from research and development to designing marketing campaigns, organizing events, investor relations, customer training, sales training, and other areas far removed from the lab. Service department opportunities include the setup and repair of instruments or assisting customers in establishing their applications on the instrument. These positions require excellent knowledge of the instrument technology as well as good people skills for direct interaction with lab customers.

It might be surprising that even relatively introverted scientists have been very successful in sales positions, especially for technology products used in the laboratory. Scientists who go this route typically acquire a deep knowledge of products and their use so that they are able to effectively explain benefits rather than just features to potential customers considering a purchase. Technical buyers appreciate and value sales professionals who are able to provide product information that is directly relevant to their particular situation. Scientists interested in pursuing this profession should apply to manufacturers of the products that they currently use and prefer since they are more likely to be successful selling products for which they have shown a preference. Sales can also be one of the more lucrative career choices when compensation includes a commission structure.

Some lab workers have close ties and an extensive network of colleagues within professional or trade associations allied with their industry. These relationships might be leveraged to obtain a full-time position, although most of these are nonprofit organizations, so pay scales may be lower than in the industrial/commercial arena but they may offer greater job satisfaction. This type of move can preserve decades-long friendships with peers from competing companies while utilizing strong relationships for the betterment of the industry. The ability to work well with others and to foster teamwork are typically attributes critical for success. Also, the ability to accomplish objectives through persuasion rather than through authority is needed since work may be accomplished by volunteers.

After spending years working in a laboratory, many scientists do not realize the unique industry knowledge that they have accumulated or its potential value outside their organization. Consulting is a way to take their experience beyond the lab to solve problems for similar labs that lack the expertise. Compensation can be good but irregular, so good financial management and discipline are required to avoid personal deficits—no work, no pay. Acquiring clients and building a reputation can be very stressful for a new consultant, so a strong network of contacts within the field of interest is advisable for those choosing this path; a broad array of associates from professional or trade associations who are familiar with knowledge, skill, and work ethic is helpful. Some of those who have tried this route comment that the first year or two was exceedingly stressful and difficult, but the rewards of perseverance and success were worth it. Typically, a financial cushion to supplement income is needed for the first years.

Quality is such a high priority for labs that staff develop a deep understanding of the quality management system and its intricacies. Some may find it rewarding to build on this knowledge by pursuing a career in this field. For example, firms that register or accredit organizations to the ISO 9001 or ISO 17025 standards hire examiners and auditors to conduct field evaluations. Both commercial enterprises and government agencies utilize quality specialists to eliminate errors and waste as well as comply with relevant regulations. These types of jobs require meticulous attention to detail as well as familiarity with federal and international standards and expert knowledge of the technical aspects of quality principles or standardized test procedures. For those who wish to pursue these types of opportunities, it is advisable to seek the formal certifications obtained through coursework and testing.

Finally, for those who are simply bored with their current position and feel that there is little challenge left, a move to a different industry or type of lab might be the solution. While there are certainly commonalities among labs, each industry has unique features that can challenge the intellect. This type of cross-fertilization can be good for both the individual and the new industry as a source of new ideas. As a caution, no one wants to constantly hear about how things were done at the previous job, but recognizing areas where experience suggests improvements are possible is appreciated by a manager. And a change from an industrial environment to a different type of lab can be exciting. Who wouldn't want to work in the *CSI* lab?

Job changes are stressful but can also be beneficial for career advancement or just to preserve self-satisfaction. While it is true that a move might not work out, it is also possible that the change reinvigorates and renews the spirit. For those willing to take the risk, taking a step outside traditional paths to consider a career in an unlikely profession can be intellectually and/or financially rewarding. If a change doesn't work out, simply try again.

Dr. Wayne Collins *was laboratory manager for Solvay Polymers and BP for more than 25 years before becoming global industry marketing manager for Agilent Technologies in 2008; he retired in 2016. Dr. Collins can be reached at L.wayne.collins@gmail.com.*

Northwestern University's Sex-Based Research

FROM A MENSTRUAL CYCLE IN A DISH TO BIOPROSTHETIC OVARIES, THE CENTER FOR REPRODUCTIVE SCIENCE IS BREAKING NEW GROUND

by Rachel Muenz

Lately, the Center for Reproductive Science at Northwestern University's Feinberg School of Medicine in Chicago has received a lot of attention for two projects in particular. The first involved the development, with partners at Draper Laboratory, Inc., and the University of Illinois at Chicago, of a "female menstrual cycle in a dish," known as EVATAR. This miniature, cube-like device contains 3-D models of female reproductive organs along with the liver and uses a fluid that simulates blood. The second project, involving a partnership with Northwestern's McCormick School of Engineering, dealt with the creation of 3-D printed bioprosthetic ovaries that were tested in infertile mice. In May of this year, the university announced that those bioprosthetics had allowed the mice to successfully conceive and give birth to healthy pups.

Teresa Woodruff, director of the Center for Reproductive Science, says both projects were done in order to help better understand how to provide fertility for young cancer patients.

"Over 80 percent of pediatric cancer patients will survive their initial cancer diagnosis, but that life-preserving treatment can also affect their fertility," Woodruff says. "We think of fertility as the issue survivors are most interested in, but in the pediatric case, we're very concerned about the endocrine health of the children."

Woodruff explains that loss of fertility isn't the only consequence of cancer treatment at a young age.

"If the ovaries don't make estrogen, then the children can't transition through puberty," she says. "So the utility of a long-acting, durable bioprosthetic is to provide individuals with [the] kind of normative function that they've lost due to the off-target effect of the cancer treatment."

EVATAR, on the other hand, was created to help scientists understand how the ovarian follicles affect the biology of other tissues, Woodruff says.

"Microfluidics is a technology that's been building momentum over the [p]ast 10 years, and it's really fundamental [in modeling] the endocrine system," she says. "Because there's not been a lot of attention on the female, we wanted to include female reproductive organs as part of the equation in microfluidic conversations. That's why we started that project. It's been really rewarding—a cool project to help direct."

That lack of attention on the female sex in scientific research is an issue that Woodruff aims to address in another role she plays at Northwestern—as director of the university's Women's Health Research Institute (WHRI). While not lab-based, it brings professionals from both within and outside the biomedical research community together, providing a forum where they can stay up to date on the latest sex differences research. The institute also provides toolkits for how to conduct sex-inclusive science.

"We recognized that there was an urgent, unmet need, which was to include females in clinical studies and to have [the] female sex represented in basic science, so in animals and cells," Woodruff says, explaining why the institute was created in 2006. "The majority of studies published today include male-only cells and animals, so it was important that we make the case for XX and XY as equally valuable in the biomedical enterprise."

She stresses that the WHRI is not just about the reproductive side of the female sex, which the work at the Center for Reproductive Science is focused on along with men's reproductive health.

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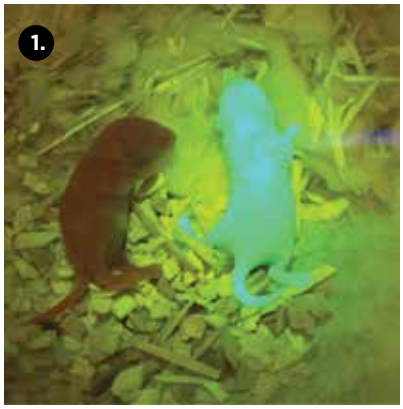
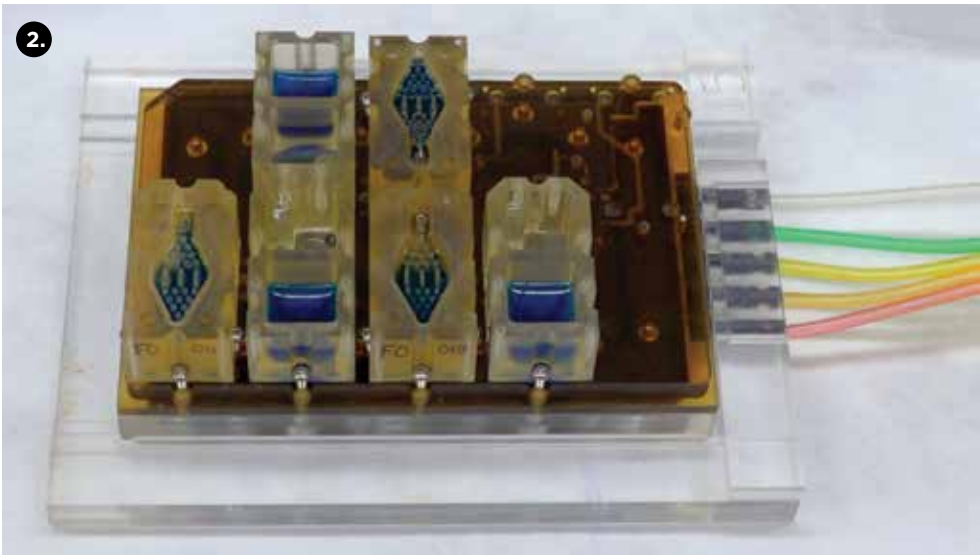
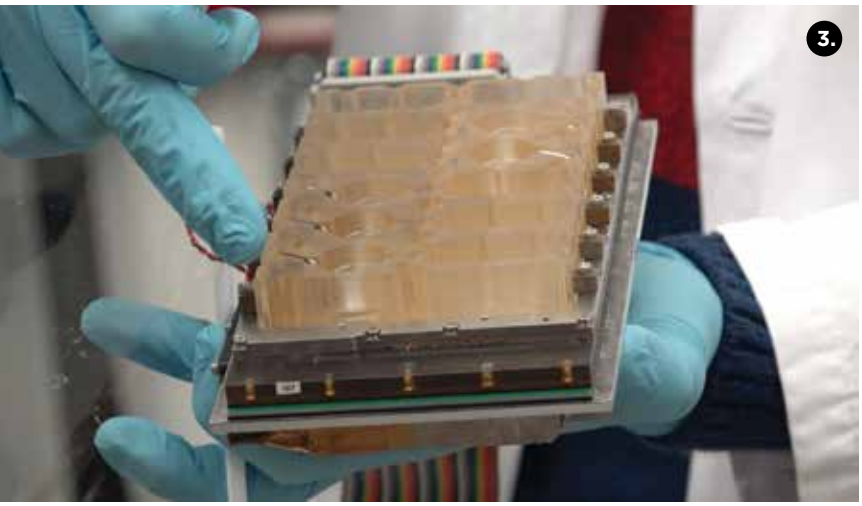
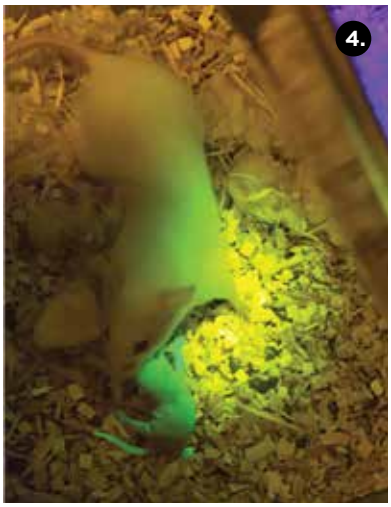








"Many people [associate] women's health research with just the reproductive axis," Woodruff says. "I want to very clearly say that the Women's Health Research Institute is about whole sex-based biology—the entire body." The WHRI's work focuses on ensuring that people understand that every cell and tissue in the body has a sex.

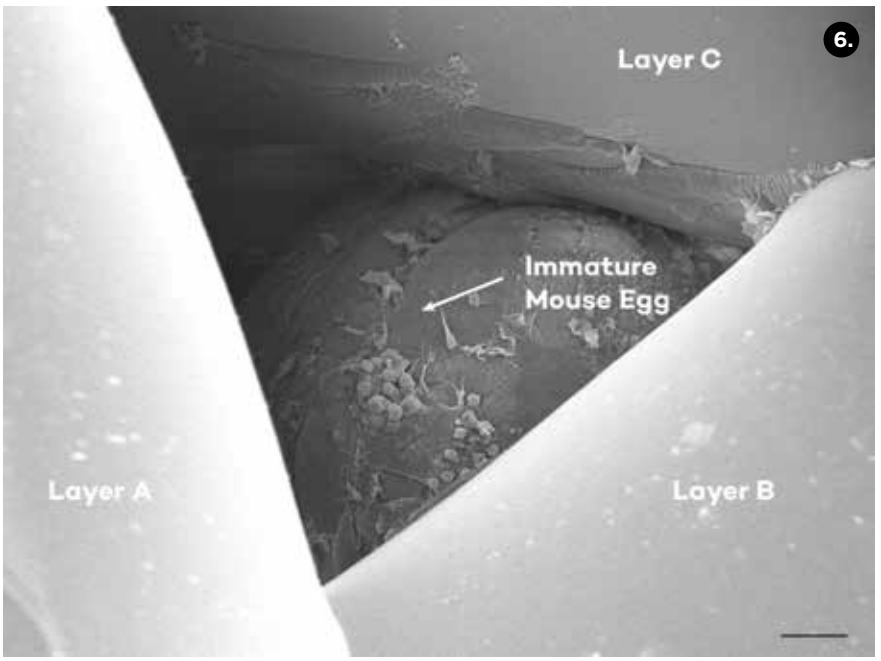
"By not including the hormones and not understanding that there might be differences imposed on cells by the X and Y chromosome[s], we're missing a lot of biological complexity and we're losing a lot of information," Woodruff says.

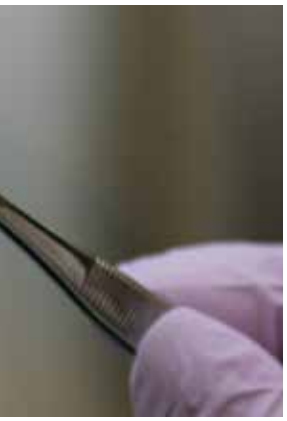
At the Center for Reproductive Science, they're exploring some of those differences in their current work building male versions of the EVATAR, known as Dude Cubes, which will include models of the testes and prostate. They also hope to develop new models of human disease such as polycystic ovary syndrome, endometrial cancer, and ovarian cancer.

"These are models that, because they interact with the other tissues in the reproductive system, we've not had good surrogates [for], and so this provides a novel opportunity for that activity," Woodruff explains.

With the bioprosthetic ovaries research, the next step is toward human transplants, with the goal of developing working bioprosthetics for patients who have lost fertility due to cancer treatment, she adds. As with most research, funding is a key challenge the center faces with that work.

"We're grateful to the National Institutes of Health [NIH], which funds all biomedical research in the United States," Woodruff says. "They are a great champion and we want to continue NIH funding, and in fact, I think it would be valuable for all of us if we grow that level of funding because that then influences the health of all of us."





1. A control mouse pup (left) lies next to a green pup (right) that was created from eggs that ovulated from the bioprosthetic ovary. The scientists created the bioprosthetic ovaries with mouse eggs that glow green to clearly see whether any mouse pups were born from the bioprosthetic ovary. If pups were born like the control, then they could have come from the mother mouse's own eggs and not from the bioprosthetic ovary transplant eggs. **2.** The EVATAR microfluidic device is a miniature female reproductive tract that contains 3-D models of ovaries, fallopian tubes, and other female reproductive organs. **3.** The EVATAR is made up of a series of interconnected cubes that feature individual tubes connecting each of the model organs. **4.** A mouse born from the bioprosthetic ovary lies next to its mother. **5.** A scientist holds with tweezers a bioprosthetic mouse ovary made of gelatin. **6.** A microscopic image of an immature mouse egg, surrounded by supportive cells and housed in a scaffold with multiple layers of gelatin.

Photos courtesy of Northwestern University Feinberg School of Medicine.

Limited time is another challenge, but one that they handle with strong collaborations, like those involved in the EVATAR and bioprosthetic projects.

"You can amplify your ability to do work by having teams working on a problem," Woodruff says. "That's been a really critical part of what we do."

Concerning the WHRI's work and sex inclusion research in general, the future looks bright.

"We believe that there is going to be an extraordinary output of new data that comes because people are now thinking about sex as a biological variable," Woodruff says. Though the NIH's rule to include sex as a biological variable in the research it funds went into effect only on January 25, 2016, Woodruff has already heard of scientists who are making extraordinary advances. "I think over the next 10 years we're going to find out more about the basis of fundamental biology [and] improve the drug pipeline, and in 10 years, we're going to look back on that date in 2016 as the most important date in biomedical research."

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CROWDFUNDING SCIENCE

WHY SCIENTISTS AND STARTUPS HAVE BEGUN CHOOSING THIS FUNDING METHOD

By Rachel Muenz

Two years ago, Susan Culican was forced to close her basic science research lab due to lack of funding.

"The funding environment was so abysmal that it literally became impossible to fund quality research," said Culican, an associate professor and director of the ophthalmology residency program in the Department of Ophthalmology and Visual Sciences at the Washington University School of Medicine.

Though she had been able to keep her lab alive for about five years on so-called soft funding through small grants from various charity organizations, that money was only enough to cover the cost of her research animals and lab technician's salary. Culican explained that many such grants require that faculty salary can't come out of that funding—which makes sense because there would be nothing left for the research—but it means that researchers have to pay their own salaries. For her, that meant more hours seeing more patients at the clinic and less time for research.

"I didn't have the quality time to put in to supervise and direct the project and be able to spend time thinking about the data," she said.

It also meant that what free time Culican did have was taken up writing grants. The research was no longer fun for her.

"It was literally spending every free minute I had writing the next grant . . . and there was no time spent actually doing the science, which is what I loved about it," she said. "I didn't want a job as a grant writer—I wanted a job as a scientist."

Ultimately, with the soft funding not being adequate and her National Institutes of Health grant applications not being funded, Culican made the difficult decision to close her lab. However, that decision eventually led her to crowdfunding, a still relatively new approach to raising funds for science.

After changing her research focus following a discussion with her former post doc advisor, Culican had an even tougher time obtaining funding, though her project has the potential to have an extremely broad impact. The question she hopes to answer is whether the average person, through crowdsourcing, can rate eye surgeons in training as well as experts. If they can, such crowdsourcing could provide a cheap and effective way to determine whether trainees are ready to practice on their own or need further training. And it could apply to other types of surgeons as well. After more unsuccessful grant applications, Culican stumbled across the science-specific crowdfunding site Experiment.com, which is based in the US.

"That [public] piece of it made me think, well, this crowdfunding approach is going to be a better approach because I want the 70-year-old who's getting ready to have their cataract surgery done to read my project," Culican said. "I want the family member who has a grandparent who had a bad surgical outcome to understand why that happened. But we have no way of measuring the surgical skill of our trainees at this point."

Culican's story is not unique, as underfunding science has been an issue for many years now, but science-specific crowdfunding sites only began to pop up around 2012. Five years later, it seems crowdfunding science is here to stay, with many scientists embracing this funding method. Experiment.com alone has funded over 700 projects, raising over $7 million.

Why scientists are crowdfunding

For Jamie Barras, head of the Humanitarian Technologies Lab in the Department of Informatics at the UK's King's College London, crowdfunding was the perfect fit for the small amount his team needed to test their explosives detector for removing landmines after conflict.

"We work in an area—humanitarian technologies research—where funding is always tight; when we realized we needed funding for an extra set of field trials beyond what our main sponsor had generously given us, we started

looking for ways to raise that; it wasn't a huge sum of money, a few thousand pounds [£5,000, around $6,500 US], but the need was there. At the same time, we knew we didn't want to get tied into a new contract or contracts that might conflict with the aims and rights of our main sponsor."

For Barras and his team, crowdfunding on Crowd.Science, a science-specific platform in the UK, offered the most freedom, plus new opportunities to engage the public in their work. That benefit of crowdfunding—engaging the public—also led Ruth Morgan, founder and director of the University College London Centre for the Forensic Sciences, to fund her project through Crowd.Science.

Her campaign aims to create a new forensic science lab to improve the interpretation of evidence in criminal cases, thus reducing miscarriages of justice—but most funding in forensic science in the UK goes toward new technologies, she said.

"We'd exhausted our options in terms of traditional funding," Morgan said. "With forensic science so embedded in society and justice, it [crowdfunding] seemed like a really positive way of trying to make sure this research happened by getting involved with the public and making sure that people understand that it's not quite like CSI. It's not as simple as just following the evidence and getting a really clear answer."

Morgan's campaign is different in that its funding goal is much higher than the average crowdfunding project where goals are usually around a few thousand dollars, as most sites recommend researchers set their funding goals below the $10,000 mark. Morgan and her team are looking for £1 million (about $1.3 million US) to fund their forensic evidence research laboratory. However, they've also gotten backing from the Alexander Mosley Charitable Trust, which has pledged to match-fund all donations, both in-kind and financial, up to a maximum value of £500,000 on a pound-for-pound basis, and received equipment donations from Oxford Instruments, JEOL UK, Foster + Freeman, and Illumina with a combined value of £95,000 (around $125,500 US).

Scientific startups

Researchers aren't the only ones in the scientific realm benefitting from crowdfunding. Lab equipment startups have also been among the success stories, though most have made their mark using mainstream crowdfunding platforms such as Kickstarter, likely

because they are offering a physical product as a reward. Opentrons, for example, funded its first personal pipetting robot, the OT-One, through a Kickstarter campaign, which provided $126,694 from 237 backers. The company's aim is to provide affordable, easy-to-use robots to scientists who would benefit from automation, but can't afford the pricier options on the market. Opentrons recently released the latest version of the robot, the OT-One S, which is twice as fast as the original.

Like Opentrons, Ezequiel Alvarez Saavedra used Kickstarter to launch his company's product, the miniPCR, a budget-friendly PCR instrument geared toward educational or small labs with tight funding. The company he co-founded, now also called miniPCR, chose crowdfunding to get its name out there and connect with more people.

"We also wanted to get the funding to jump-start production of the machine," he said. "We had been working on the machine for over a year and we had two prototypes. To start producing it in an assembly line, we needed some funding and we thought this would be a good way to do it."

As with research, crowdfunding generally provides much less funding to startups than do traditional investors, but it can be less frustrating, Alvarez Saavedra elaborated. His company was surprised at the diversity of the 245 backers who supported their campaign, which was a success, raising $66,701.

He says one of the most important lessons he learned from that 2014 campaign was to lay the groundwork before the campaign is even launched. "We did quite a bit of reaching out to contacts before we started, and we did have some publicity during the campaign." Having a large group of backers set to go as soon as your campaign launches is key, he said, adding that a clear rewards structure is also important.

"Having too many rewards is confusing for people," he said. "We had a mix of buy one, donate one. I think people liked that. So, we donated one product to schools when people bought a [miniPCR]. I think having a clean structure is really helpful." If people go to a campaign's page and there are too many rewards, or

the structure is too complicated, they're more likely to leave instead of connecting with the campaigners, Alvarez Saavedra explained.

Science-specific crowdfunding outlook

As funding for the sciences continues to get tighter, with the potential to become even more constrained due to possible budget cuts in the US and the loss of EU funding if Brexit goes ahead in the UK, could crowdfunding play a bigger role? Those who run science-specific crowdfunding sites aren't sure such cuts will have a massive effect on this funding method.

"In terms of that working in sync with massive funding cuts that are happening in the US and with Brexit in the UK, I don't think it's necessarily going to happen in sync unless members of the public say, 'Oh I don't want funding to be cut; how can I put money toward science?'" Crowd. Science founder Natalie Jonk said.

Cindy Wu, co-founder of Experiment.com, added that any cuts to research funding in the US won't affect how she and her team run their business. Their aim is to support scientists no matter what the funding environment is.

"Our mission remains the same, to democratize the research process so that anyone can do science," she says. "The only way this affects my thinking is I spend a lot more time thinking about how we can make science move faster."

However, there have been a few changes since Experiment.com got started. At the beginning, her team was more focused on ensuring funding for projects, but they "now measure success by the number of projects that are successfully executed." The site's funding success rate continues to be a steady 45 percent. Wu adds that making science more accessible and reproducible takes up most of her time nowadays.

"How do we bring out the recipe of science and make it available to anyone who wants to do science? You can start to see the beginnings of this at experiment.com/labnotes, where our community shares the scientific research process. We believe the magic is in the process, not in the proposal or the final peer-reviewed paper," Wu said.

A major challenge Experiment.com is working on now is tackling the historic problem of only established scientists getting funding, while young researchers struggle. They have shifted their focus to work with scientists who are of graduate student age or younger. "We need to arm our young scientists with more power if they are to make it in the current system," Wu said.

Across the pond, Jonk's Crowd.Science is focusing on building stronger communities around various research areas, so that there are more backers ready to go for projects, making it easier to predict how well campaigns will do. "We can say, 'We've got X number of people who are interested in this, probably X number of them will be interested in this specific project,' and then it will be more predictable as to how much will be raised," Jonk said. Building stronger partnerships with charities, instrument vendors, and other large organizations is another focus. Since its start, the site has hosted 30 projects and had a total of £0.7 million pledged so far (around $925,000 US).

"Overall our mission is to help scientists be in a position to do the research that they want to do," she said. "Sometimes that [assistance involves the] funding and sometimes companies give equipment in-kind and we can help be involved in those [partnerships]."

Next month, we'll wrap up our series on crowdfunding in science with Part II, which will cover the challenges of this funding method, more of the benefits, and the keys to a successful campaign.

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EFFECTIVE KNOWLEDGE MANAGEMENT

TOOLS AND TECHNIQUES

by Scott D. Hanton and Vincent G. Grassi

Charles Steinmetz, the wizard of Schenectady, was the most famous electrical engineer of his day. The story goes that when Henry Ford had exhausted the Ford Motor Company's resources trying to fix a large electrical generator, he called on Steinmetz for help.[1] Steinmetz arrived in Detroit and called for a pencil, paper, chalk, and a cot. After two days, he drew a line on the generator's housing and asked the technicians to replace 16 wire windings. He submitted a bill for $10,000, a large sum in those days. Ford, surprised, requested an itemized invoice. Steinmetz replied:

1. $1 to draw a chalk line
2. $9,999 to know where to draw it

Ford paid the bill.

"Sharing knowledge with colleagues is an excellent way to retain knowledge within the organization."

For every organization, people are the key asset. Their knowledge defines what the business knows and can accomplish. The knowledge of the staff is also constantly changing, and the knowledge needed for the organization is constantly changing too. This presents lab managers with several key knowledge management challenges, including how to identify:

- The knowledge possessed by the people
- The knowledge that is unique
- New knowledge needed by the organization
- How to effectively share and transfer knowledge

The knowledge owned by an organization can be located in numerous places. Most labs are familiar with the variety of concrete knowledge or documented knowledge around the lab. Familiar documents containing important knowledge include reports, notebooks, methods, databases, shared drives, and hard drives. The aspect of the organization's knowledge more difficult to identify and locate is the tacit knowledge contained in people's heads.

Knowledge management is a set of processes and tools to address this organizational need. Here is a set of proven knowledge management processes and tools that will benefit most lab managers:

- Identification of critical knowledge (TVA grid)
- Knowledge-retention tools
- Knowledge mapping
- Communities of practice
- Idea management
- DeBono's six hats
- Best-practice sharing
- Lessons learned

Each of these tools will be discussed in this article.

Knowledge management tools

Critical knowledge grid

The critical knowledge grid[2] used by the Tennessee Valley Authority (TVA) is an excellent tool to map who has the critical knowledge and how much risk there is of losing it. Figure 1 shows the TVA critical knowledge grid.

Figure 1: TVA's critical knowledge grid, showing the criticality of the knowledge and the predicted risk of losing it.

Leave within 2 yrs					
Leave within 6 yrs	Duplicate skills exist in company or easy to get in market		Tacit knowledge but easy to transfer		Tacit knowledge critical to going forward; hard to find in the market
	Criticality of Knowledge				
	Generally Known				Irreplaceable

The lab manager can use the grid to document and manage knowledge transfer based on which staff have what levels of critical knowledge and when they might be expected to leave the organization. Retirement is not the only reason, as people often exit the organization for transfers, promotion, or personal reasons, so being aware of workforce transitions is critical.

Knowledge retention tools

Sharing knowledge with colleagues is an excellent way to retain knowledge within the organization. Lab managers should use the tools in Table 1 during cross-training to retain specific knowledge in the organization.

Table 1: Knowledge retention tools for cross training

Tacit Tools	Explicit Tools
Storytelling	Documentation
On the Job Training	On the Job Training
Mentoring	Wiki
Lessons Learned	
Shadowing	
Wiki	

Storytelling enables senior staff to tell some of their favorite stories, and they usually talk about why in addition to what and how. Effective examples of how NASA uses storytelling to transfer knowledge are given in DeLong.[3]

On-the-job training and shadowing are related tools. In shadowing, the student watches the teacher execute a task, and in on-the-job training, the teacher watches the student work.

Mentoring provides the opportunity to pass not only tactical knowledge but also culture from experienced staff to younger people.

Writing internal wikis enables staff to explain pertinent details of the work and explain why different decisions are made.

Lessons learned enable the lab manager to establish a learning culture and take advantage of both positive and negative outcomes for learning for the whole organization.

Knowledge mapping

Knowledge mapping[4] enables the lab manager to choose a specific process important to the organization and follow who requires specific elements of knowledge, who has it, and when it is needed. For many technical organizations, the knowledge map resembles other process maps that are familiar to technical staff.

There are several benefits of constructing knowledge maps. The process of creating the map forces lab managers to think critically about what knowledge is needed. Using the maps emphasizes the importance of knowledge sharing and generates an effective tool for less-experienced staff. Of course, there are also challenges in creating effective knowledge maps, including getting the right people in the room and motivating people to share and manage organizational knowledge instead of hoarding knowledge. As with any other effective business process, an important challenge is to institutionalize the process so that the knowledge is always up to date.

Community of practice

Figure 2 shows the Air Products knowledge management model based on communities of practice.[5]

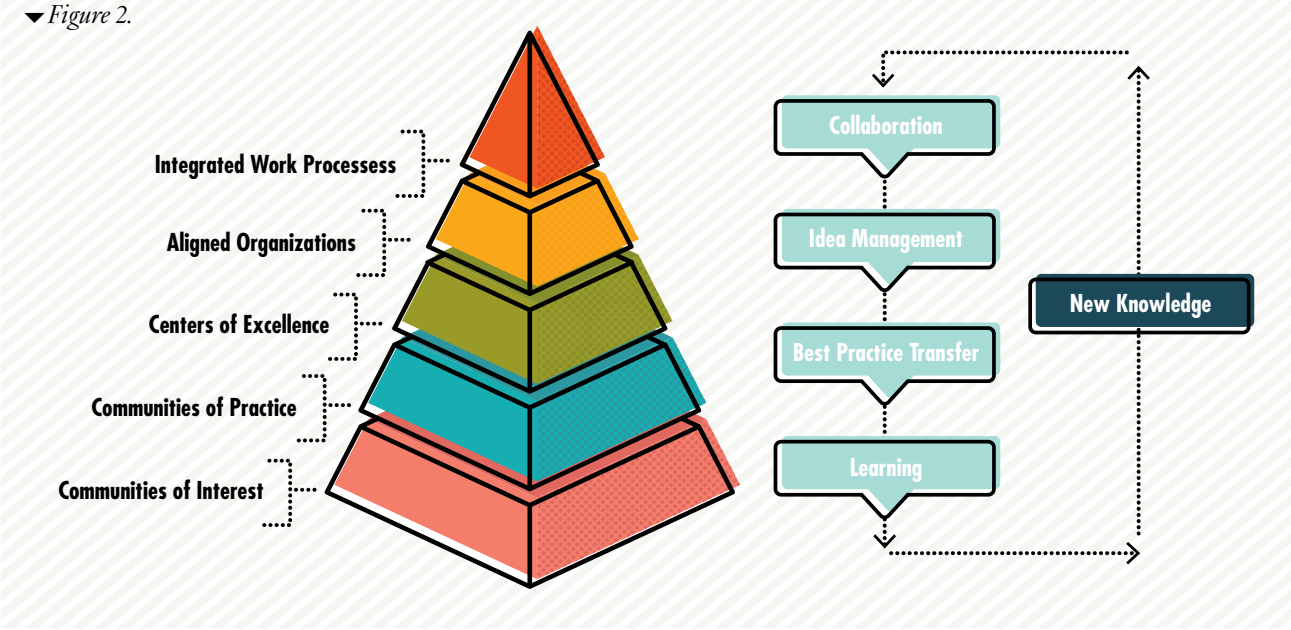
Communities of practice (COPs) are focused on a general area of interest. The object is to bring a group of volunteers together with responsibility to achieve the community's business goals. COPs are self-managed, hold regular meetings and events, and communicate regularly about the benefits they generate. The outcome of a COP is to nurture knowledge sharing and mutual learning from others within the community.

Idea management[5]

New challenges require new ideas. As lab managers, we need to have mechanisms to encourage, attract, and evaluate new ideas. There are many ways to ask for new ideas; for example, a physical idea box, a virtual idea box, email, dropping by to chat, the Internet, networking, and brainstorming. A management process that requires active management of ideas through submittal and workflow will work well for an organization.

Once new ideas are generated, the ideas need to be sorted and evaluated. Mind-map software[6] or other nonlinear tools can be very effective in sorting new ideas. All new idea submissions must be evaluated. That needle in the haystack may be there. In addition, all submitters must be notified about their ideas. Lack of feedback will stifle the flow of good ideas. Good ideas need to be developed. Some relatively small fraction of ideas will hit the mark.

Figure 2.



De Bono's six hats

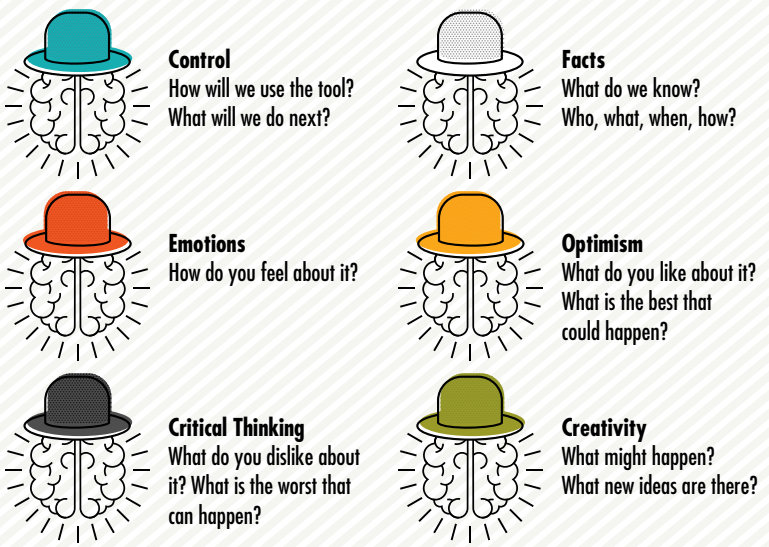
All humans carry unintended bias into most decisions. Lab managers need ways to counter the natural bias. Some common biases that need to be addressed include:

- Confirmation bias—selective search for evidence
- Premature termination—accepting the first alternative that might work
- Cognitive inertia—unwillingness to change
- Selective perception—screening out information
- Wishful thinking—seeing things in a certain (usually positive) light
- Choice-supportive bias—distortion of memories of chosen and rejected options to make the chosen options seem more attractive

One useful tool to counter unintended bias is de Bono's six hats.[7] Using the tool provided by de Bono enables a more objective way to evaluate ideas or make decisions. The six hats approach enables a group to effectively consider all sides of an issue. Everyone wears the same hat at the same time, and everyone participates in every part of the discussion.

Table 2 shows the six hats.

Table 2.



Once the new ideas have been sorted and evaluated, some can be tried. The good old scientific method is often a good way to experiment with new ideas. Demonstrated ideas can be implemented. Implemented ideas can be good practices. Some good practices can become best practices—maybe it will work for someone else too.

Best practices

A best practice is the current best way of doing work that has been implemented.[5] The method is generating measurable benefits, and the idea can be replicated elsewhere in the company.

Best-practice sharing brings many advantages to the organization, including helping it:

- Save money
- Share best vendors and pricing
- Rapidly share proven solutions to common problems
- Rapidly get input on possible solutions
- Seek proven solutions
- Rapidly share experience globally to related operations
- Connect people from different areas, businesses, or regions
- Rapidly share opportunities

Lessons learned

As mentioned above in the discussion of knowledge retention tools, lessons learned can be a powerful tool to create and propagate a learning culture. A popular and highly effective process for the capture and fast transfer of lessons learned is the after-action review.[8] Lessons learned are designed to enable individual and organizational learning. The tool can be utilized before, during, or after any event or project. The lessons learned approach is primarily a tacit knowledge tool; participation is the key. It brings insight to not only what, how, or when things were done but also why they were done.

A lessons learned tool consists of five questions:

1. What did you expect to happen?
2. What actually happened?
3. Why did it happen?
4. What can we learn?
5. What do we need to do based on our learning?

Both positive and negative results should be discussed. To enable full participation, no blame or finger-pointing is allowed.

Lessons learned can bring significant benefits to the organization:

- Create a culture of learning
- Create a psychologically safe environment
- Share what people know
- Prevent the repetition of undesirable outcomes
- Appreciate new ideas
- Impart tacit knowledge that is difficult to express in writing
- Give background, context, and history; explain why
- Describe issues encountered
- Reveal how problems were solved
- Help align a team with their work

Summary

Knowledge is critical for any organization. Lab managers need to know the who, where, when, why, and how of a high number of different processes and protocols. To be successful in this role, the lab manager needs proficiency in a number of different knowledge management tools, a number of which were reviewed in this paper. A strong knowledge management program will retain critical knowledge, seek new knowledge, and generate a learning organization.

Acknowledgments

The authors would like to acknowledge colleagues past and present at Intertek, Lehigh University, and Air Products.

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BRINGING THE LAB TO THE FIELD

THE LATEST HANDHELD INSTRUMENTS FOR REMOTE USE

by Erica Tennenhouse, PhD

Testing and analyzing samples typically requires that those samples first be transported to a laboratory. However, sometimes it is preferable or necessary to conduct testing and analysis on-site, wherever that may be. Field instruments have become essential in a wide range of applications, including monitoring environmental parameters, identifying materials, measuring components of food, detecting narcotics, and testing pharmaceuticals. With many recent advances, the latest handheld devices on the market are lighter, faster, more accurate, and more user-friendly than their predecessors.

Keeping tabs on the environment

Handheld instruments have increasingly enabled those conducting environmental tests to obtain real-time results from often-remote field locations.

pH is commonly measured in water and soil as an indicator of pollution and environmental health. The new Jenway portable pH meters offered by Bibby Scientific can be used in the field, eliminating the need to take samples back to the lab. Model 550 is a general-purpose portable pH meter that displays both temperature-compensated pH readings and temperature, while Model 570 is a handheld pH, mV, and temperature meter that displays either temperature-compensated pH readings or electrode potential and temperature readings.

Jenway portable pH meter.

If the need for laboratory-quality gas chromatography arises in the field, there is a new platform from Falcon Analytics that can deliver analyses from any vehicle with at least a 250 amp alternator. The CALIDUS Mobile GC System can be applied to all sample types, whether they are in a liquid or a gas phase. Among its applications, the instrument can perform environmental emissions monitoring, such as spill and leak quantification and automotive emissions testing.

The CALIDUS Mobile GC System.

Recording data in the field can be challenging, particularly in remote locations with limited Internet access. The new Matrix Gemini Field Analytics System from Autoscribe Informatics extends the use of their LIMS (laboratory information management system) to the field, allowing test data to be recorded off-line and uploaded to the LIMS when an Internet connection can be reestablished. The Field Analytics System is designed to operate on an Android tablet or mobile device and to sync with the Matrix Gemini LIMS database.

The Matrix Gemini Field Analytics System from Autoscribe Informatics.

At this year's American Society for Mass Spectrometry conference, FLIR Systems announced the Griffin G510 Gas Chromatograph-Mass Spectrometer (GC/MS), the company's first person-portable chemical identifier. Among its applications, the system equips environmental monitoring and remediation teams to analyze chemicals in real time. Designed to withstand harsh environments, the FLIR Griffin G510 enables users to easily sample all phases of matter, including solid, liquid, and vapor, in order to rapidly identify chemical hazards in the field. The device comes equipped with an integrated heated sample probe designed for downrange missions. When used in survey mode, it identifies vapor-phase chemicals within seconds. The split/splitless injector allows environmental, forensic, and hazardous material sampling by enabling syringe injection of organic liquids. "The FLIR Griffin G510 is a groundbreaking chemical analysis tool that brings versatility and lab-quality performance and identification to the field," says Dennis Barket, Jr., vice president and general manager of FLIR Detection.

Analyzing materials

Whether one is sorting, identifying, or testing materials, time is often of the essence; a handheld device can significantly speed up the process.

Oxford Instruments' new Vulcan, a handheld laser-induced breakdown spectroscopy (LIBS) analyzer, can measure metal alloys in just one second. The speed of the device allows large inventories of incoming raw materials or finished parts to be checked very quickly and large quantities of scrap metal to be sorted in scrapyards easily and quickly. According to Mikko Järvikivi, product manager, Oxford Instruments, Vulcan "delivers unparalleled speed, ease of use, and ruggedness while still providing accurate and precise results for all common alloy types."

The Vulcan metal analyzer from Oxford Instruments.

SPECTRO Analytical Instruments recently upgraded its SPECTRO xSORT handheld X-ray fluorescence (XRF) spectrometer to provide greater speed and precision in the analysis of light elements. The device is ideal for performing positive material identification for infrastructure integrity testing at refineries, power plants, and petrochemical complexes and for scrap metal analysis and sorting in the recycling industry. The SPECTRO xSORT Alloy model delivers grade identification in seconds. The even more powerful SPECTRO xSORT AlloyPlus model is capable of analyzing most alloys in two seconds, and it identifies alloys based on light elements such as aluminum, magnesium, silicon, phosphorus, and sulfur in seven seconds.

◀ *The SPECTRO xSORT handheld XRF spectrometer.*

Although it works as quickly as the handheld XRF, SPECTRO's new SPECTROPORT portable arc/spark optical emission spectrometer (OES) is better suited to accurately analyze elements such as carbon, sulfur, phosphorus, boron, lithium, beryllium, calcium, silicon, magnesium, and aluminum at low and critical levels. The unit is smaller and lighter than the mobile SPECTROTEST OES analyzer and can be used cordlessly with a rechargeable battery pack for testing in difficult-to-reach places.

Food and beverage testing

Because many foods are perishable, portable testing devices are essential for determining the compositions of foods we consume, for testing food authenticity, and for identifying substances that could potentially be harmful.

For those taking brix measurements of fruits and vegetables, alcoholic and nonalcoholic beverages, and seasoning sugars, JM Science offers the new Portable Brix Meter BX-1. The device is a handheld brix meter that can be used easily by anyone in any location, can take measurements in two seconds, and comes equipped with a wide measuring range and a long-lasting battery that allows a user to run more than 30,000 measurements.

▲ *The Portable Brix Meter BX-1 from JM Science.*

Wine sometimes gets tainted with trichloroanisole (TCA), a natural compound that is formed from precursors present in the wood of the cork tree that impart an undesirable smell. The analysis of TCA in tainted wines generally requires sample preparation like liquid/liquid extraction, solid-phase extraction, or distillation methods, frequently with the disadvantage of organic solvent use. Measuring TCA in wine is also challenging because wine contains many additional compounds at low concentrations. The zNose® from AZO Materials is a small and portable handheld GC that attains 10-second speed with the use of a direct heated, one-meter column and a new solid-state integrating GC detector. This device is the first electronic nose that has accomplished reaching the same level of sensitivity to TCA as a panel of wine experts has.

Elucidating drugs

Drug manufacturers and law enforcement agencies increasingly require powerful and sophisticated yet easy-to-use handheld technology for analysis of medicinal drugs and narcotics.

Thermo Scientific has recently broadened the list of drugs detectable by its TruNarc handheld narcotics analyzer. The most recent software update adds dibutylone, furanyl fentanyl, and U-47700 to its onboard library, which now includes nearly 300 suspected narcotics and narcotics precursors and an additional 80 common cutting agents. "The TruNarc analyzer's latest library update is designed to equip field agents with updated capabilities to stay ahead of emerging narcotics threats and more quickly get drug users the treatment they need," says Denzil Vaughn, director of marketing for portable analytical instruments at Thermo Scientific. The analyzer accurately identifies chemicals using Raman spectroscopy.

◀ *Thermo Scientific's TruNarc handheld narcotics analyzer.*

Raman technology is also the basis for the latest handheld spectrometer from Metrohm USA—the Mira M-3. This device is ideally suited for pharmaceutical applications, as its software integrates compliance with FDA regulations. It also offers audit trails and secure electronic records. Unlike with similar handheld instruments that

The Mira M-3 handheld Raman spectrometer from Metrohm USA.

hide control of data collection, Mira M-3 users can save a method and distribute it to one or more instruments.

For its part, Rigaku Analytical Devices has developed a handheld Raman analyzer that is fully compliant with the regulations set last year by the European Pharmacopeia detailing acceptable wavelength shifts and associated tolerances for benchtop and handheld Raman instruments for pharmaceutical applications. The Progeny™ 1064nm handheld Raman analyzer successfully overcomes sample-induced fluorescence interference with the use of a unique 1064nm excitation laser. This feature also enables measurements to be taken through packaging. Bree Allen, general manager and vice president of the molecular business for Rigaku Analytical Devices, commented, "Progeny represents the cutting edge of handheld Raman technology, helping customers to achieve leaner manufacturing processes and lower costs per analysis without compromising quality, and now is a great time to upgrade outdated Raman systems to achieve a streamlined workflow."

The Progeny™ 1064nm handheld Raman analyzer from Rigaku Analytical Devices.

For those working outside the lab, handheld devices provide the opportunity to bring some of the lab with you. As they continue to advance, field instruments are becoming increasingly useful additions to the scientist's toolkit.

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COMBATING HAZARDS

DEVELOPING A SUCCESSFUL HEALTH AND SAFETY TRAINING PROGRAM

by Vince McLeod

Have you ever had to attend an after-lunch training session? Or, even worse, had to give a presentation to a room full of cell phone users and nodding heads? Well, read on for tips on how to develop training that will keep your attendees interested and focused.

We all can agree that laboratory research facilities contain more than their fair share of hazards. A wide array of hazards is usually present given the typical assortment of chemical laboratories, instrument rooms, chemical storage, waste handling and busy receiving/loading docks. Every workday our employees must deal with these hazards while hopefully avoiding accidents and injuries. As you must admit, well-trained employees do a much better job at this than average or untrained workers. So, let us take a look at evaluating and improving your training programs.

"Examine your current training model using the OSHA draft model training guidelines."

Daily work in research laboratories poses constant risks to our health and safety. These take the form of chemical safety, ergonomics, fire safety, hazard communication, housekeeping, material handling and personal protective equipment. These potential hazards and the training needed to combat them have not gone unnoticed, as more than 100 OSHA standards for the control of hazards in the workplace contain requirements for training in order to reduce potential for injury. During the period between 1980 and 1996, 80 reports were reviewed where training was used to reduce the risk of work-related injury.[1] This NIOSH review found vast evidence supporting the value of training in increasing worker knowledge of job hazards and effecting safer work practices. On the other hand, they found a lack of training was a contributing factor in worker injuries and workplace fatalities, further reinforcing the review's findings. A quick read of this publication should stimulate you into taking the time to assess your current training programs.

As they say, "Start with the end in mind" whether you are developing a new training program or evaluating an existing one. By this, we mean you should have a clear idea of what you hope to achieve. Training experts refer to this as defining your performance objectives. To begin, ask these three important questions:

1. Can your employees recognize and identify the hazards in the workplace?
2. Can your employees recognize how these hazards result in personal injury, property damage, or both?
3. Can your employees describe and apply appropriate safe work procedures and practices to cope with these hazards?

In order to answer the above questions, we recommend starting with your facility's safety record. Hopefully, an accident/injury reporting system is in place where you can pull all recent accident and injury reports and trace them to their source area. If not, start one now! Remember to include reports of near misses and close calls. A careful review of your accident/injury data should help you identify areas of your facility, particular job tasks, or positions needing training. Using these data, you can prioritize training topics and target your audience.

In developing your safety training program, the next step is to examine your current training model using the OSHA draft model training guidelines. These seven steps will guide you through the entire process from development


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to delivery, and then circle back to the top for evaluating and improving your training programs. The seven guidelines are summarized here:[2]

1. **Determine whether training is needed.** Are engineering or physical controls needed? Should the work process be changed or is it really a question of increasing employees' knowledge of safe work practices?
2. **Identify training needs.** Examine the facility's health and safety records. Go over your job hazard analyses. Solicit worker or supervisor perceptions and suggestions to identify what training is needed and where improvements can be made. Do not forget to include applicable federal and state requirements.
3. **Identify goals and objectives.** Clearly state what the training is intended to achieve, and develop explicit, observable evidence that it has been met. In other words, a specific objective is much better than a vague goal.
4. **Develop learning activities.** Good instruction that targets well-defined objectives should include mental and/or physical skills required to meet the specified needs. Use of actions and situations that simulate actual conditions are very effective. In addition, allow employees to demonstrate that they have assimilated the desired knowledge through specific activities.
5. **Conduct the training.** The teaching format should invite worker participation and provide hands-on exercises to promote active learning. Use of the many means of motivating and maintaining student interest is encouraged. Emphasizing the benefits and relating the training to current skill levels and experiences are among the best methods.
6. **Evaluate program effectiveness.** Determine whether the training has accomplished objectives for each training session. Use of student/trainee opinions and feedback, as well as supervisor observations and workplace improvements, are recognized as effective for this purpose.
7. **Improve the program.** Revise aspects of the training based on evaluations from the previous step. Offer periodic retraining. Determine course deficiencies and identify needed revisions by repeating all steps of the training model.

The role of training in developing and maintaining effective hazard avoidance is borne out in the reams of literature and safety training studies performed. The question is not whether safety and health training can reduce risks from workplace hazards, but rather how to maximize these training effects. Following the OSHA draft model training guidelines will put you on a path of building an excellent occupational safety and health training program. Working through the seven guidelines and emphasizing the last two, evaluating the effectiveness and improving the programs, will reward you with reduced injuries and a better educated and motivated workforce. For those needing shortcuts, OSHA has developed sample programs for many areas that you might want to check out.[3]

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21ST-CENTURY SAFETY SOLUTIONS

NEW CLOUD-BASED SOFTWARE EASES THE BURDEN OF SAFETY TRAINING

by Matt Airhart

Ensuring your lab employees have met their required training obligations and are in compliance with hazard communication (HazCom) standards places a lot of responsibility on your shoulders. Fortunately, new technology is available to ease the burden.

Cloud-based software makes it easy to install a solution without the need for IT involvement or long and expensive implementations. Now, lab supervisors and chemical hygiene officers responsible for environment, health, and safety (EHS) have a host of available options for managing safety training and critical chemical hazard information in ways that are faster, easier, and more affordable than traditional paper-based methods. More efficient software systems enable lab workers to stay current on training with less disruption to productivity, can provide simpler access to safety data sheets (SDSs), and reduce the burden of tracking and reporting on EHS activities.

The following are three quick ways technology alleviates laboratory safety training concerns.

Training flexibility and reach

With lab workers operating on different shifts and often on tight schedules, it can be difficult to bring employees together for classroom or group trainings. Complicating matters are the wide variety of state, federal, or specific facility-based regulations that cover lab activities. Even when it is possible to get employees together for training, it's difficult to ensure they have grasped all the necessary information.

Training software offers on-demand instruction to help solve these issues, allowing lab safety managers to assign and administer modular courses as needed and confirm training requirements are being met with at-a-glance management and completion tracking. Workers can complete training on their own schedules and at their own pace, allowing them to better comprehend the material.

Lab standard and HazCom compliance

Access to hazardous chemical information, like that found on SDSs and workplace labels, goes hand in hand with laboratory training and is vital to worker safety. The SDS in particular provides the necessary information for employees to put their training into action, such as required personal protection equipment, proper chemical handling and storage, and spill response procedures. Employees must be trained on the HazCom standard and/or the OSHA Lab Standard in general, including how to avoid any dangers associated with the hazardous chemicals they work with, what to do in the event of an incident, and where and how to access the lab's SDSs and chemical hygiene plans.

> "Frequent safety meetings have been shown to directly reduce the number of severe workplace incidents."

Chemical management software solutions streamline employee right-to-know access, making it faster and easier to access SDS inventories via a web-based system versus searching through paper binders. With better access to critical chemical safety information, employees can remain focused on applying the training they've received to their daily tasks.

Day-to-day safety briefings

Frequent safety meetings have been shown to directly reduce the number of severe workplace incidents by conveying present concerns and reminding workers of the training they've previously received. Unfortunately, coordinating and managing safety meetings can be a real challenge. Just finding the time to bring everyone together, staying on topic, and tracking who was present for which session are pain points to contend with.

Electronic safety meeting solutions make lab safety updates easier by simplifying the process of scheduling meetings, inviting attendees, assigning roles, distributing topics and agendas, automating pre- and post-meeting notifications, and creating records of conversations with the ability to carry over action items and unresolved topics to the next meeting. Even better, meeting documentation can be recorded and archived in one centralized system for compliance purposes.

Today's technology can be a game-changer. For those tired of tracking down employees who are past due on training or are worried about what will happen if an inspector visits, now is a good time to start evaluating EHS software solutions.

Matt Airhart *is a vice president at VelocityEHS, a cloud software provider with easy-to-implement and easy-to-use environment, health, and safety solutions. For more information, visit www.EHS.com or call VelocityEHS at 1-888-362-2007.*

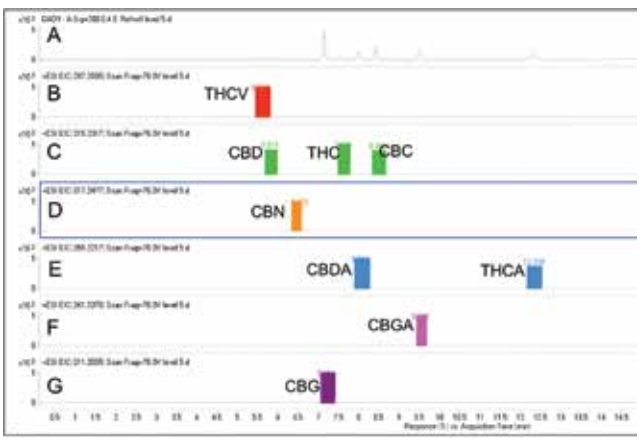
MEASURING CHEMICALS IN CANNABIS

AS THE INDUSTRY GROWS, SO DOES THE INCREASED NEED FOR POTENCY TESTING

by Mike May, PhD

Medicinal cannabis is legal in more than half of the United States, plus a collection of countries around the world, including Australia, Canada, the Czech Republic, Mexico, and Poland, with more probably likely to follow suit. Consequently, cannabis-based products made for medical purposes need to be tested for potency to ensure the proper dose. What's more, cannabis used for recreational purposes should also be tested. Despite the youth of this industry, applicable analytical techniques do exist.

Cannabis contains dozens of cannabinoids, which are usually cited for their medicinal qualities. In addition, cannabis contains various tetrahydrocannabinols (THCs), which provide the plant's euphoric effects. The question is: Which ones should be measured for a product's potency? The answer depends on who is doing the testing. Different organizations or states can set up their own testing requirements. In many cases, those regulations remain in development. Commonly, labs will test for tetrahydrocannabinolic acid A (THCA) and Δ9-tetrahydrocannabinol (Δ9-THC) and report "total potency," because THCA rapidly converts to THC under drying, manufacturing, and pyrolytic conditions.



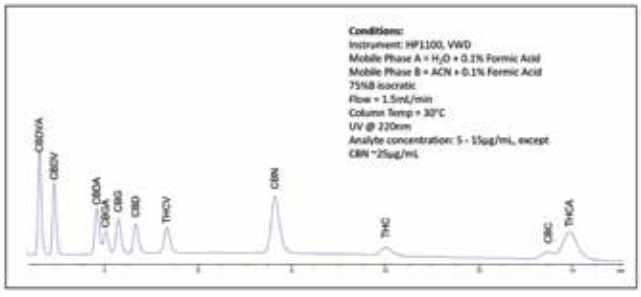
▲ *In this analysis of a 10-compound cannabinoid mix with the Agilent 1290 Infinity II UHPLC-6230B LC-TOF-MS system, chromatogram A is the UV signal at 280 nanometers, and B–G are the LC-TOF-MS-extracted ion chromatograms for each cannabinoid. (Image courtesy of Agilent.)*

As this industry develops, even more components could be tested. As examples, Bob Clifford, general manager of marketing at Shimadzu Scientific Instruments (Columbia, MD), says there is "growing interest in tetrahydrocannabivarin acid (THCVA), cannabidivarinic acid (CBDVA), and cannabichromenic acid (CBCA), but standard reference materials may be difficult to purchase."

The increasing list of components to test creates part of the challenge. In addition, other chemicals in cannabis make it more difficult to measure the ones of interest. The cannabis also gets processed in various ways, which means that both the raw material and the final product need to be tested in some cases, particularly where the product is intended as a therapy. Getting all that right requires the appropriate equipment, methods, and operators.

METHODS FOR MEASURING

Anthony Macherone, senior scientist at Agilent Technologies (Santa Clara, CA) and visiting professor at the Johns Hopkins University School of Medicine (Baltimore, MD), says that the company has "multiple platforms [for cannabis potency testing], ranging from high-performance liquid chromatography, HPLC, with an ultraviolet, UV, detector to LC plus time-of-flight mass spectrometry, LC-TOF-MS."



▲ *HPLC can reveal a range of chemicals in cannabis. (Image courtesy of Emerald Scientific.)*

Other vendors also use similar approaches. Clifford calls HPLC with a UV detector the "gold standard" for measuring the most commonly tested components of cannabis. He adds, "The important goals for cannabis testing are ruggedness and repeatability along with quantitative accuracy."

For the main components of cannabis, HPLC/UV provides a fast and economical test. For even faster runs, a lab can use ultra-HPLC (UHPLC). This technology, though, is more expensive.

To get a more in-depth measurement of a cannabis sample, more advanced technology is required. "It has been reported there are more than 130 lesser-known cannabinoids," Clifford says. These can be identified with various forms of mass spectroscopy.

Someone could buy the equipment and set up a cannabis-testing lab, but what is required to run one? According to Macherone, it requires someone at the "technician level for basic HPLC-UV quantitation of cannabinoids." For cannabinoid research and drug discovery/development, he says, someone with a PhD should be in charge.

Some cannabis lab personnel lack the desired chemistry background for these advanced analytical platforms. "To help overcome the differences in education/experience, Shimadzu introduced a platform for the nonscientist called the Cannabis Analyzer for Potency that allows nonchromatographers to use the system," Clifford says.

Other vendors also work on technologies that make it easier for labs to complete the necessary testing. Agilent, says Macherone, "offers a platform-agnostic solution that best fits the lab's current and future needs."

SEEKING SOLUTIONS

Someone setting up a new cannabis-testing lab can also turn to Emerald Scientific (San Luis Obispo, CA). Chief technology officer Amanda Rigdon describes the company as a "supplier of lab reagents and equipment dedicated to the cannabis analytical industry."

This company consults with customers about what they need, as well as what they can afford. "The finances vary widely, from someone who sold a car to buy an instrument on eBay to someone with $1.5 million in investment money," Rigdon says. The desired throughput also matters. A customer needs to buy a system that will meet his or her requirements, and—if needed—expand to new capabilities in the future.

Beyond the instrumentation, Emerald Scientific also provides customers with protocols to test for potency. Rigdon runs her own lab at the company, where she can test new methods, and she is working on validating them. Whatever protocol a lab runs, she says, "being successful is in the details."

If a customer runs into trouble, Rigdon does what she can to solve the problem. She'll even review data if a customer allows that. She says that some of her customers have taught themselves HPLC. "It can be done," she points out, "but having some knowledge beforehand is desirable."

Some of the self-taught and not-taught-at-all people in cannabis testing give the field a bad name in some areas. Nonetheless, Rigdon stands up for the people running these labs. "We need to realize that as an industry, the lab side is only six years old," she says. "Still, the magnitude of improvement over six years is equal to what we saw in food safety and forensics over a couple decades."

So, testing cannabis for potency—testing it for anything—remains an industry in development. That is true for the instrumentation and methods, as well as the people running the labs. Even the customers must evolve to understand that the least expensive testing is not always the best. That means that everyone must work together to find the best solutions for this industry.

***Mike May** is a freelance writer and editor living in Texas. You may reach him at mike@techtyper.com.*

PROBING NEUROLOGICAL DISEASES WITH STEM CELLS

TAILOR-MADE CELLS FUEL ASSAY DEVELOPMENT

by Angelo DePalma, PhD

Induced pluripotent stem cells (iPSCs) have turned the market for assay-worthy cells on its head. No longer are researchers limited to rare primary cells that die after a few generations, or genetically unstable transformed cells. Thanks to iPSCs, investigators can research any cell type, limited only by their expertise in assay creation.

Axol Bioscience (Cambridge, UK) derives its name from Axolotl, a Mexican salamander that regenerates limbs and heals wounds without developing scar tissue. Company founder Yichen Shi, PhD, earned his doctorate at the Gurdon Institute at Cambridge, named for Sir John Gurdon who co-discovered iPSCs and shared a Nobel Prize for his work in 2012. Collaborating with another Cambridge-based company, Horizon Discovery, Axol applies gene-editing technology to create disease models from these cells.

Why not simply reprogram cells harvested from individuals with the diseases in question?

Shi explains the challenges of collecting large numbers of samples from such patients, especially for commercial research: "It is much easier to introduce defined genetic modifications with tools like CRISPR into iPSC lines." This approach enables highly controlled studies of disease-related genes. "It allows us to analyze phenotypic differences among cells of identical genetic background except for the induced mutations."

Gene editing also allows creation of specific disease-affected cell types, e.g., cortical neurons, from genetically modified iPSC lines engineered with any of several Alzheimer's-related mutations. Such cultures are invaluable for creating *in vitro* human disease models and cell-based assays for drug discovery.

Axol intends to become the go-to supplier of iPSC-derived neuronal cells, delivered in configurations that allow users to determine the assay format. Yet Shi notes that "physiologically relevant disease models are only half the battle in drug discovery. Success depends on a robust, reliable, physiologically relevant assay that represents real-world pathophysiology."

> "Physiologically relevant disease models are only half the battle in drug discovery."

3-D CULTURES

Last year, STEMCELL Technologies (Vancouver, BC) entered into a licensing agreement with the Institute of Molecular Biotechnology (IMBA) of the Austrian Academy of Sciences for commercial rights for cerebral organoid culture, and developed the STEMdiff™ Cerebral Organoid Kit.

Organoids are three-dimensional multicellular structures that mimic living tissue—in this case the brain. Thus, they provide a convenient platform for modeling neurological diseases. Specifically, the organoids recapitulate early human embryonic brain development. IMBA scientists have already used them to model microcephaly, with the expectation that they will serve as additional neurologic disease models.

Cerebral organoids complement STEMCELL's existing portfolio of products for neural cell culture, including the NeuroCult™ and STEMdiff product lines, together with the new BrainPhys™ Neuronal Medium.

"Cerebral organoids aim to recapitulate *in vivo* brain development and therefore contain a wide variety of cell types," says Erin Knock, PhD, a scientist at STEMCELL. These include neural precursors, neuronal subtypes from various brain regions, and glia. Organoids produced using the Lancaster protocol, for example, contain neurons from both the dorsal and ventral cerebral cortex, including both inhibitory and excitatory neurons.

STEMCELL uses a special medium, BrainPhys, for growth and maturation of mature neurons, not specifically for neuronal stem cells. "It's formulation mimics elements found in cerebral spinal fluid, which is what

these cells are normally exposed to in the brain," Knock adds. "Because this environment better represents the brain's extracellular environment, neurons cultured in BrainPhys show improved synaptic activity compared [with] those cultured in alternative neuronal media."

Cerebral organoids have been used to study neural stem cell proliferation and differentiation, neuron maturation, migration, and connectivity. They are amenable to techniques used in traditional neural culture, including marker expression by immunohistochemistry, measuring electrical activity of neurons using patch-clamp recordings or minielectrode array, and even single-cell characterization using flow cytometry. "More recently, cerebral organoids have been characterized using high-resolution single-cell RNA-sequencing and epigenomic profiling, showing that they are highly similar to fetal neuronal structures at eight to nine weeks postconception, further validating their value in modeling early human brain development," says Knock.

Because of their similarity to early fetal brain tissue, cerebral organoids have been best used to study neural developmental disorders like microcephaly, Miller-Dieker Syndrome, and Autism Spectrum Disorder. They can also model neurologic effects of Zika virus infection, which sometimes results in microcephaly.

"But neurodegenerative diseases such as Alzheimer's, Parkinson's, and Huntington's will require innovations in 3-D cell culture to improve the maturation process of organoids to better model events beyond early embryonic stages," Knock says. Another advancement will be development of cocultures incorporating additional cell types, such as endothelial cells and microglia, to 3-D cerebral organoid systems.

NEURODEGENERATIVE DISEASES

Researchers from the Francis Crick Institute (London, UK) have used iPSCs derived from human skin to learn how some motor neuron diseases begin and progress at cellular and molecular levels. The team, headed by Drs. Sonia Gandhi and Rickie Patani, both group leaders at Crick and consultant neurologists at the National Hospital for Neurology, are working with pharmaceutical companies to discover new treatments for motor neuron diseases, particularly amyotrophic lateral sclerosis (ALS).

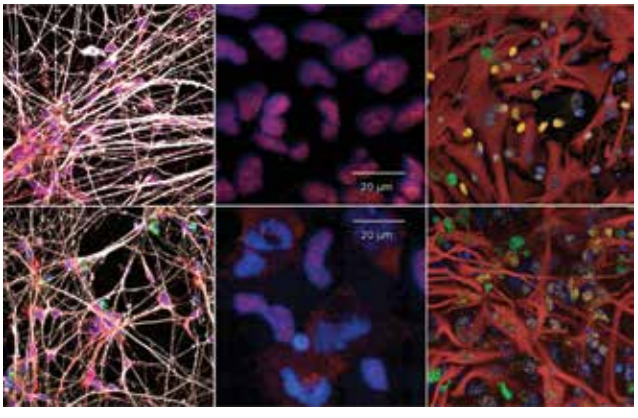
The research, published in *Cell Reports*, shows how the function of astrocytes, healthy motor neuron-supporting cells, may become impaired in ALS, highlighting their role in neurodegenerative diseases.

"Understanding how and why neurons die is vital to understanding neurodegenerative diseases, as is understanding the role of astrocytes in this context," Gandhi says.

Researchers harvested skin cells from healthy volunteers and patients carrying the genetic mutation that causes ALS and transformed them into iPSCs. They then guided the cells to differentiate into motor neurons and astrocytes in a way that closely resembles specific regions of the spinal cord from which motor neurons arise.

The team first induced neural conversion, then turned the neural precursors into cells common to the spinal cord domain from which motor neurons arise. From this point, differentiation diverges for spinal cord motor neurons and astrocytes.

By tracking healthy and disease-prone motor neurons over time, the scientists found that the protein TDP-43 leaks out of the nucleus of disease-prone neurons, causing a chain reaction of damage to crucial components of the cell's machinery, leading to cell death. By modelling ALS in this manner Gandhi and Patani identified events occurring early in disease onset, before neurons showed signs of stress. A potential therapeutic intervention might involve preventing TDP-43 from exiting the nucleus, removing it entirely from the cytoplasm, or replenishing it within the nucleus.



▲*Left column shows healthy human motor neurons (top) and VCP-mutant ALS motor neurons (bottom; dying cells appear green). Middle column shows a protein known as TDP-43 stays in the nucleus of healthy cells (top) but leaks out in VCP-mutant cells (bottom) causing a sequence of pathogenic events that damage several crucial parts of the cells' machinery. Right column shows that healthy astrocytes can somewhat rescue VCP-mutant motor neurons (top; dead cells appear green), while VCP-mutant astrocytes fail to support survival of VCP-mutant motor neurons (bottom) to the same degree as healthy astrocytes.*

Cell-based assays can take a variety of forms. "We deliberately developed an adherent culture that is more amenable to phenotypic assays and RNAseq," says Patani. "This approach minimizes heterologous cell-cell interactions that may exist in suspension culture and thus allows cell-autonomous phenotypes from highly enriched cultures to be detected more easily. We appreciate that organoid culture is gaining real momentum now and are exploring this as a future possibility in our experiments."

She mentions a potential hurdle to translating these findings to human ALS. "Human iPSC derivatives likely represent a fetal maturational state and so this is a potential consideration here. Also, we are studying enriched populations of particular cell types. While this allows us to resolve issues of cellular autonomy optimally, it does not recapture the multilineage *in vivo* setting in which diverse cellular interplay may also contribute to disease development and progression."

HUNDREDS OF LINES

Neuralstem (Rockville, MD), which develops nervous system therapies based on neural stem cells, recently published preclinical data on NSI-566, spinal cord-derived neural stem cells, in *Journal of Neurotrauma*. These data showed robust engraftment and long-term survival of NSI-566, human spinal cord stem cells, in a rat model of penetrating ballistic-like brain injury. NSI-566 is Neuralstem's lead stem cell therapy candidate.

No approved treatments exist for traumatic brain injury except for physical rehabilitation. Neural stem cell transplantation into the injured brain, if effective, would therefore fill a significant medical need.

Neuralstem's technology enables commercial-scale production of multiple types of central nervous system (CNS) stem cells, which are under development as potential therapies for CNS disorders and as disease models for testing small-molecule drugs. Screening against the company's human hippocampal stem cell line has led to the discovery of molecules that Neuralstem believes may stimulate the brain's capacity to generate new neurons, potentially reversing CNS conditions.

Neuralstem has developed hundreds of neural stem cell lines representing diverse anatomical regions of the developing human CNS. NSI-566 was derived from spinal cord, but the company has produced analogous cell lines representing cortex, hippocampus, and cerebellum, as well as other regions of the brain.

The cells are produced using proprietary methods and retain their capacity to expand as a multipotent population and differentiate into physiologically relevant neurons and

glia. "Because they are derived from the CNS during fetal development they retain their commitment to region-specific neural differentiation, which provides a significant safety benefit in the development of cell therapies," says Tom Hazel, PhD, senior vice president of research.

New neurons form in the adult brain—through a process known as neurogenesis within the hippocampus. Hippocampal neurogenesis plays a role in learning and memory, and recent evidence links defects in adult hippocampal neurogenesis with psychiatric disorders such as depression and schizophrenia.

Because of the role of hippocampal neurogenesis in these processes, Neuralstem initiated a program for screening small-molecule compounds with neurogenic activity that have the ability to cross the blood-brain barrier. "We used a cell line derived from the hippocampus to perform this screen, and the lead compound that resulted was NSI-189, which is currently in clinical trials for the treatment of major depressive disorder," Hazel tells *Lab Manager*. Results of the Phase 2 study are expected in the third quarter of 2017.

Not all such potential therapies target new cell generation. A benefit of using stem cell lines for screening is the ability to generate practically unlimited numbers of cells for screening. "We can screen for compounds that act at any point in the lifecycle of neurons or glia," Hazel adds. "We can use high-content analysis to evaluate the effects of drug candidates on a broad array of endpoints, including synapse formation and protection of neurons against toxic insults. These cells are also an ideal platform to screen for safety and toxicity during the drug discovery process."

Neuralstem is also working with models of neurodegeneration based on differentiated human neural stem cells in culture, any of which could be leveraged to screen for neuroprotective compounds. Among these are *in vitro* models for exposure to beta-amyloid peptide for Alzheimer's disease, and other toxic conditions that induce neuronal cell death.

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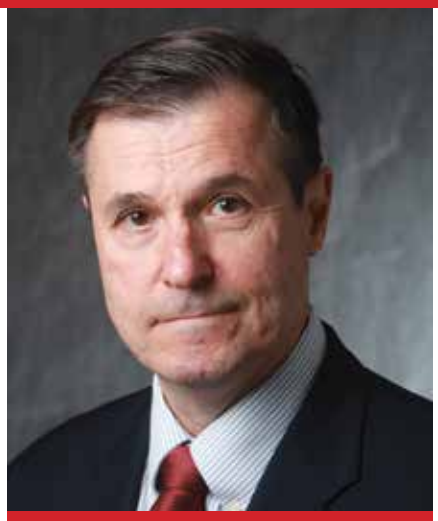

Professor Robert J. Linhardt

ASK THE EXPERT

DEVELOPMENTS IN CAPILLARY ELECTROPHORESIS MASS SPECTROMETRY (CE-MS)

by Rachel Muenz

Professor Robert J. Linhardt received his PhD in chemistry from Johns Hopkins University in 1979 and did postdoctoral studies at MIT. He is the Anne and John Broadbent Jr. '59 Senior Constellation Chair in Biocatalysis and Metabolic Engineering at Rensselaer Polytechnic Institute. His research focuses on glycoscience and he is an expert on glycosaminoglycans. He has received multiple honors, including the ACS Isbell, Hudson, and Wolfrom Awards; the Volwiler Research Achievement Award; and the Scientific American 10. Dr. Linhardt is a fellow of the National Academy of Inventors, holds over 50 patents, and has authored over 800 research articles.

Q: What does your lab do?

A: We're primarily interested in the analysis of carbohydrates, particularly charged carbohydrates. There are a lot of big names for them—but some [simple] examples are heparin, which is a drug, and chondroitin sulfate, which is also a drug. We are very experienced in analyzing these types of carbohydrates.

Q: How did your lab get involved in CE-MS?

A: A lot of my colleagues work on proteomics while we're more interested in glycomics, so glycan analysis. With proteomics, there are really good separation methods for peptides that are HPLC [high pressure liquid chromatography]-based, so capillary electrophoresis is not as important, but there is some potential there as well to do proteomics using CE or CE-MS. With carbohydrates, though, they're very hydrophilic and often they're very charged. The carbohydrates we work with in particular are highly negatively charged. There are limited ways that you can analyze them on columns and most of those ways would require salts. And those [salts] are generally not compatible with mass spectrometry. So we began working on CE-MS with [an industry] colleague—Qiangwei "James" Xia. He's very skilled and runs a company called CMP Scientific, which is a small start-up in Brooklyn, New York. [It has] developed something that I think is really important in this area, which is the CE-MS interface.

Q: Why is the interface so important?

A: Before this interface, it was very difficult to interface capillary electrophoresis and mass spectrometry. We can use capillary electrophoresis widely to do analysis of glycans, and we think it's a profoundly important technique because, again, carbohydrates don't work very well in partition chromatography like HPLC. Separations are not very good and you have very restrictive conditions. But with capillary electrophoresis, we don't have a packing material so we don't have to worry about partition or binding to a column and then releasing, we're just separating carbohydrates based on their migration times from an open capillary. We think capillary electrophoresis is an excellent way [to perform separations], but until we had a CE-MS interface that worked, we were unable to do these types of experiments. We could separate with capillary electrophoresis, but then we couldn't really analyze what we had separated. So we basically had to first make standards, and then we would use these standards in capillary electrophoresis to just do the separations and use co-injection or spiking experiments to determine what was eluted. An online CE-MS technique was really challenging until we had a good interface.

Q: How has working with the interface gone so far?

A: We used the interface at CMP Scientific and found that it worked really well for glycan analysis for the types of glycans we work with. Using the interface, we were able to separate by two primary methods used in capillary electrophoresis [see http://bit.ly/2r0zdFX and http://bit.ly/2r0Dl9b], and then we used a simple mass spec method on the separated analytes that relies on an LTQ Orbitrap mass spectrometer that's available in almost any analytical lab nowadays. We were able to get really good data with [the CMP] interface with both separation methods. So in glycan analysis, we think this type of approach is good. I know James is also interested in peptide analysis, and he thinks [the interface] would work well there also. We knew that both CE and mass spectrometry worked well for us, but once we saw an interface that worked and used it, we were able to apply it and answer some really major questions.

Q: What is your lab currently working on with CE-MS?

A: We're looking at analysis of biological samples like urine or plasma using this type of CE-MS method. Its advantages

over HPLC are that it takes less sample prep [and] requires smaller sample size, and the columns don't really clog the same way that HPLC columns would because there's no packing to these columns; they're open capillary. We're working with a colleague at the University of Georgia, Jon Amster, and he was able to get an R21 grant from the National Institutes of Health that we're coinvestigators on. We're now using CE-MS there on some samples that we've prepared to try to do rapid analysis of either biological fluids or drug products. We're trying to optimize the mass spec side of the interface now, since the CE side is pretty good.

Q: What are some of the key trends in CE-MS?

A: CE is not widely used in the pharmaceutical industry and certainly not widely used by clinical chemists. It's more of a niche technology, but it has some advantages over HPLC, which is the mostly widely used separation method. Certainly a lot of LC-MS [liquid chromatography-mass spectrometry] is used right now in both the pharmaceutical industry and by clinical chemists. Why we like CE is [that] its resolution is higher than HPLC and LC, and it can be faster. Why there are some issues about it in the pharmaceutical industry and clinical chemistry groups is that, first of all, they don't have a lot of experience with capillary electrophoresis. Since they have less experience, they go with what they know, which is LC-MS instead of CE-MS. There's some variability in the time it takes an analyte to go through a CE separation, and that variability makes clinical chemists and pharmaceutical scientists worry about using this technology. But when it's linked to MS, the migration time variability is less of a problem because MS can measure exactly what's coming out at what moment. That removes one of the limitations of the method. The idea would be to get [the CE-MS interface] into core laboratories. My colleague at CMP Scientific would love to sell the interface and hopefully promote the use of capillary electrophoresis with mass spectrometry in both the pharmaceutical and biotech industries and also in clinical chemistry labs.

Q: What other applications of CE-MS do you find most interesting or promising?

A: Certainly the glycan analysis is something I'm interested in. Most biotherapeutics today are things like antibodies or recombinant proteins that are glycosylates, so they're glycoproteins. It's important to know the glycan component of those products in both the biotech and pharmaceutical industries. In clinical chemistry, they realize that metabolomics and proteomics are really important. Right now, the throughput is pretty low because it takes a long time to do these analyses. If they had an interface that gave them a faster analytical time, then it would just be a question of processing the data faster. So I think that CE-MS will provide shorter run times than HPLC and LC-MS. It's an important breakthrough.

Q: Where do you see the technology going in the distant future?

A: We develop a lot of new analytical technology in the glycan area. In the distant future, a lot of people are talking about laboratory-on-a-chip analysis. You can do capillary electrophoresis on a chip, on a very small device—so you can miniaturize it. The problem right now is that we can't miniaturize the mass spectrometer, but people are working on this. NASA is interested in putting mass spectrometers in probes that are landing on Mars or other planets, so I think as miniaturization of mass spectrometry takes place, there is potential there in the distant future of having laboratory-on-a-chip [instruments] that can do this type of analysis. In the not-so-distant future, people are resistant to trying new technology, but I'm sure they'll find problems that they can solve using this method that they can't solve using conventional methods.

Q: What do you enjoy most about working with CE-MS?

A: I always like to answer really fundamental questions, and the technology allows us to answer some questions that we couldn't answer otherwise. I also like to learn from people who design instrumentation and interfaces—the mechanical parts—since, by training, I'm a chemist. I know the chemistry and separations really well, but I'm always interested in working with people who know the instrumentation as well because I learn something new, and that's always exciting. I always want what we do to move out into the real world. We're hoping that these types of technologies get applied where they can help people in clinical laboratories or help develop new products in the pharmaceutical or biotech industries.

Q: Any advice for those new to CE-MS or thinking of adding it to their labs?

A: It's not that different, with this interface, from LC-MS. If they have experience with LC-MS, putting in CE-MS doesn't require very much additional learning. It's not a big learning curve, and a lot of that learning curve has probably been achieved in developing this CE-MS interface at CMP Scientific. There are other interfaces out there as well, but this one we just believe works really well and it's pretty simple.

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HPLC

CHARGED AEROSOL DETECTION IDENTIFIES A WIDE RANGE OF ANALYTES AT HIGH SENSITIVITY

by Mike May, PhD

Getting to the right part of a sample and identifying the desired components make up the foundation of many scientific studies. For analytical techniques in the life sciences, this foundation often consists of a separation method, such as high-performance liquid chromatography (HPLC), paired with an appropriate detector. With HPLC, scientists often use ultraviolet (UV) detection, but some samples don't absorb UV light. That demands the need for other techniques, such as charged aerosol detection (CAD).

"Often with LC detectors, one analyte responds more strongly than another, or may not respond at all," says Paul Gamache, director of R&D at Thermo Fisher Scientific (Waltham, MA). "What is very often desired is the ability to obtain a quantitative response for a wide range of analytes independent of their specific chemical properties." CAD provides that kind of response for any nonvolatile analyte.

Many scientists call CAD a universal HPLC detector, because it works on all sorts of samples. The analytes in a sample do not need any particular properties, like color, fluorescence, or ionizability. Moreover, CAD is highly sensitive and can provide a consistent response for nonvolatile analytes, including those lacking UV absorption. "Because it works by coating whatever comes out of the HPLC in charged nitrogen atoms and then detecting the amount of charge, it's essentially an 'everything detector,'" says Vanessa Quinlivan, a biology graduate student at Johns Hopkins University (Baltimore, MD). Consequently, CAD can pick up a variety of analyte classes in one experiment, and it does so with high sensitivity.

Detection details

The mechanism of CAD spawns its wide appeal. "CAD can detect any nonvolatile and most semi-volatile analytes and has been used for a wide range of applications—for example, pharmaceutical development, protein/peptide measurement, lipid analysis, and polymer characterization," says Zhengyuan Zhou, a research fellow in the school of pharmacy and biomedical sciences at the UK's University of Central Lancashire.

As mentioned, CAD transfers charge to analyte particles whose size and therefore charge depend on analyte mass concentration. "Any high-mobility species, such as gas ions, that did not interact with the analyte particles are removed by an ion trap, while the now charged particles pass to a collector where the aerosol's aggregate charge is measured with a very sensitive electrometer," Gamache explains.

The signal from the detector goes to a chromatographic data system (CDS), such as the Thermo Scientific Chromeleon CDS. "The signal produced is directly proportional to the mass-flow of analyte," says Gamache. So, CAD quantifies the injected mass of nonvolatile analytes in a sample independent of their molar mass and chemical properties.

Some scientists might think of CAD like an evaporative light-scattering detector (ELSD). Both are evaporative aerosol detectors, but the performance differs significantly. "With decreasing analyte mass, the response drops nonlinearly and essentially disappears with ELSD but not with CAD," says Gamache. "The nonlinear drop in sensitivity with ELSD often leads to under-estimation of lower level analytes, such as pharmaceutical impurities, and significantly complicates any limit of detection calculation." In optimized conditions for both detectors, studies by scientists at Thermo Fisher Scientific showed that CAD is far more sensitive than ELSD is. "For an on-column injection of 7.8 nanograms of both theophylline and caffeine, the signal-to-noise ratio for theophylline with ELSD was 2 compared with 238 with the Corona Veo CAD," says Gamache. The ELSD didn't even detect this amount of caffeine.

CAD in the lab

Researchers can use CAD with HPLC in many ways. As an example, Zhou points out that researchers use HPLC-CAD in his lab to characterize cross-linked micelles, which are nanoparticles made from polymers. These can be modified in many ways, which makes them useful for drug delivery.

FOR ADDITIONAL RESOURCES ON HPLC, INCLUDING USEFUL ARTICLES AND A LIST OF MANUFACTURERS, VISIT WWW.LABMANAGER.COM/HPLC

"CAD is ideal for the detection of the polyethylene glycol-based nanoparticles that have no UV chromophores," Zhou notes. "It also allowed us to monitor the degradation of the nanoparticles under various pH conditions." In addition, these scientists recorded the hydrolysis of the nanoparticles with CAD, but it was invisible to a UV detector.

CAD also works very well in lipid research. "The array of lipids in a single biological sample—like plant oil or an extract from animal tissue—can be so diverse in terms of their chemical properties," says Quinlivan. HPLC-CAD does a great job of identifying components of those diverse samples.

In Steven Farber's lab at the Carnegie Institution for Science (Baltimore, MD), where Quinlivan works as a graduate student, researchers study lipid metabolism in a larval zebrafish model. "We use HPLC-CAD to examine how the total-body lipid composition of larval zebrafish changes depending on what they eat," Quinlivan explains. Using HPLC-CAD, Quinlivan and her colleagues can detect and quantify a large array of phospholipids, triglycerides, fatty acids, cholesterol esters, and free cholesterol—all in the same sample.

For instance, studies from Farber's group showed that the triglyceride content of larval zebrafish increases by about five percent after they consume a single high-fat meal. "The same method also allows us to look at the effects of genetic mutations on the lipid profile, and to see how lipids change in the early developmental stages as the embryo absorbs its yolk—the nutrient supply it is born with, consisting of a lipid mixture—over the first five days of life," Quinlivan explains.

Buy it for breadth

Even this brief overview of HPLC-CAD shows its versatility. As Gamache says of CAD, "because it offers more sensitivity, a wider dynamic range, and a more consistent response independent of analyte properties than other technologies, it can be used for many applications." Those applications stretch from biotechnology and biopharmaceuticals to natural products and specialty chemicals.

So, your lab can explore a range of application areas with the same HPLC-CAD setup. This might not make a universal research platform for everything that you ever want to do, but it can cover many separation and detection needs, especially in life science applications.

Mike May *is a freelance writer and editor living in Texas. You may reach him at mike@techtyper.com.*

WHAT DO FTIR SPECTROPHOTOMETER USERS HAVE TO SAY?

FTIR is useful for the analysis of organic and inorganic compounds that exhibit changes in polarity as a result of the vibration, spinning, or perturbation of molecular bonds. FTIR methods are common in such industries as foods, materials, chemicals, pharmaceuticals, forensics, and others. Advantages of FTIR over conventional IR are higher resolution, better signal-to-noise, easier analysis of very small samples and poorly-absorbing species, and much more rapid analysis.

Most common problems users experience when using their FTIR spectrophotometer:

Low signal	**46%**
Noise	**46%**
Scanning problems	**43%**
Peak shape	**19%**
Poor absorbance accuracy	**16%**
Wavelength accuracy	**14%**
No signal	**8%**
Not meeting published resolution specifications	**3%**

Factors that would help users overcome their FTIR spectrophotometer challenges:

Better technical support	**45%**
Better training	**40%**
Improved maintenance	**37%**
Newer equipment	**30%**
Newer accessories	**17%**
More staff	**5%**

TOP 5 QUESTIONS

You Should Ask When Buying an FTIR Spectrophotometer

1. What applications are you using FTIR for? This will determine what type of FTIR spectrophotometer will be the best fit for you. For example, if you will be conducting most work outside the lab, a portable instrument is likely a good fit. FTIR microscopy may also be an option you'll want to consider, depending on what type of research you do.
2. What sort of environment will you be working in? If you are out in the field, in a humid area for example, the instrument should be tough enough to handle the conditions.
3. Who will be using the instrument? If non-experts will be the main users, it makes sense to go for a user-friendly instrument that won't take too much time to learn to use. The complexity of the software is also important to consider.
4. What accessories are available for the instrument and how wide is their range?
5. As with most instruments, you should ask what sort of service and support the company provides for the FTIR spectrophotometer, and its cost in terms of acquisition, running the FTIR, and maintaining the instrument.

SOME OF THE MOST EXCITING APPLICATIONS

for FTIR, as reported by users:

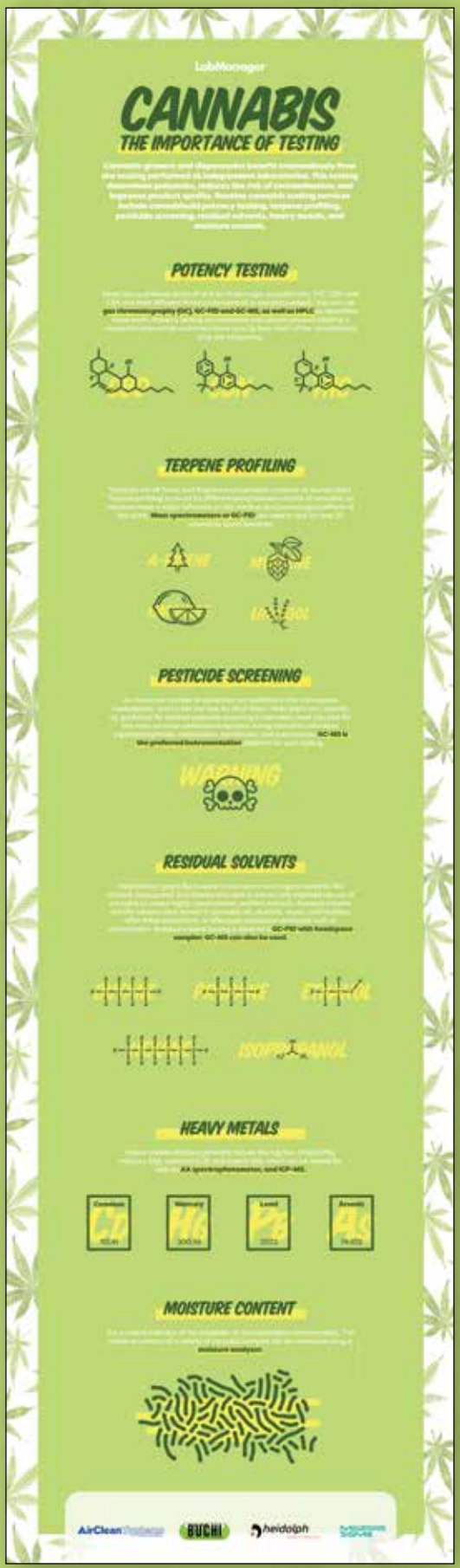
FTIR Microscopy

Fourier transform infrared (FTIR) microscopes, used in conjunction with FTIR spectroscopy, enable visualization of a sample while its components are being analyzed. The many applications for FTIR microscopy include pharmaceuticals, materials science, forensics, and environmental testing.

Deformulation

Deformulation is the process of breaking down of a formulation into its basic components with the aim of reconstructing the original formulation. FTIR is an effective analytical technique for identifying the ingredients in solid or liquid samples, regardless of whether those components are volatile or non-volatile.

For more information on FTIR, including useful articles and a list of manufacturers, visit www.labmanager.com/FTIR



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Thomas Neubert, PhD

ASK THE EXPERT

TACKLING SAMPLE PREP FOR MASS SPECTROMETRY

by Tanuja Koppal, PhD

Thomas Neubert, PhD, professor of cell biology and director of the New York University Protein Mass Spectrometry Core for Neuroscience, talks to contributing editor Tanuja Koppal, PhD, about analyzing small molecules and proteins from diverse samples using mass spectrometry (MS). He discusses some of the common issues that researchers often overlook when it comes to sample preparation. These issues, although seemingly trivial, have a significant impact on the separation of samples and analysis of data and could lead to false discovery and misinterpretations.

Q: Can you describe your work and the types of analyses you do?

A: I have been running a mass spectrometry core lab at the New York University School of Medicine since 1998. We collaborate with many researchers to use MS for analysis, and at any given time we have many different projects going on. Our main interest is in neuroscience, although we do work on other projects as well. Because we work on many projects we have to process a variety of samples and use different types of MS instruments. Some samples are tissues, others are cell culture, plasma, or serum. We analyze both proteins and small molecules in these samples and do most of the sample preparations ourselves.

Q: How important is sample preparation for your analysis? Can you explain some of the details?

A: Sample preparation is very important. For analyzing proteins, we usually get the protein in the form of a pellet or in a sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE) gel. The main processing steps include digesting the protein into peptides using trypsin and fractionating or cleaning the peptides before putting them in the MS instrument. The exact processing steps depend on whether we are studying a protein or a small molecule, as the two workflows are very different. For studying posttranslational modifications, such as phosphorylation, ubiquitination, and glycosylation, on proteins, we have to enrich the modified peptides so they can be seen using MS. So that's an important step. However, if we just have to identify the proteins and not measure their quantities, then we do only fractionation of the complex mixture and no enrichment. After the samples are processed, we inject them into a nanoflow high-performance liquid chromatography (HPLC) column, which is coupled to MS. While some labs study intact proteins, we typically study only peptides, which makes it easier for MS analysis. The small molecules that we study are typically metabolites found in the cell.

> "The exact processing steps depend on whether we are studying a protein or a small molecule, as the two workflows are very different."

Q: Along with sample prep, I am assuming data analysis is also very important?

A: Data analysis is extremely important for what we do. We often analyze a few thousands of proteins after each LC-MS run. When we combine data from many different runs, we sometimes have to analyze 8,000-9,000 proteins at a time. We have to identify not only the proteins that are there in the sample, but also how much of each protein is present. We do relative quantification for most of our analysis and this requires advanced software. The Association of Biomolecular Research Facilities (ABRF) has a proteome informatics research group (iPRG), which often conducts various studies. In one such study, they gave a set of MS data to different labs around the world and asked them to analyze it. Using the same data, these labs found different proteins or different quantities of the same protein. That tells you how important data analysis is. This has been very consistent across many studies that the group has done. Even the same lab, when using different instruments or lab personnel, can generate different results. Hence, leading proteomics journals are now requesting that researchers submit their raw data along with the manuscript. Scientists looking at the data then don't have to rely only on the analysis

done by the lab publishing the results. Journals also require a certain standard for data analysis, and reviewers are now requesting details on analysis and statistical significance.

Q: Is there any improvement in sample prep and data analysis with this new mandate?

A: The field is improving but there continue to be challenges as new technologies are introduced and data sets get larger. Experiments have to be done carefully, and controls have to be used appropriately, so there are no mistakes in data interpretation. Experimental conditions have to be monitored, and there can be no bias when selecting samples, especially for clinical research. Even in cell biology experiments, conditions have to remain identical, with the exception of a few variables, when it comes to making accurate comparisons. As instruments like MS become more sensitive, researchers can analyze very small amounts of samples. However, sample processing also has to improve to accommodate these small amounts of material. Technologies have now moved to single-cell analysis with RNA sequencing, but analyzing proteins and small molecules in single cells is still quite difficult. To do that, you have to be able to process the cell and extract the analyte in a reliable way, which is very difficult and often involves microfluidics. At the same time, there are innovations taking place all the time to help with sample preparation.

Q: How do you overcome some of the challenges with sample preparation?

A: Working with different types of samples can be challenging, so it's important to hire people who are skilled and collaborative, so they are willing to share their knowledge and techniques with others. I rely heavily on senior lab members to teach the junior members, so our protocols can be passed down to the next generation. Everyone who joins my lab learns the basics of sample preparation, which is extracting the proteins, digesting them, purifying, and fractionating them. However, some people develop expertise working with a particular sample type. For instance, some have more experience working with small tissue samples, while others work better with cell culture. Every individual has a niche, and sometimes they have to develop new methods for a specific type of sample based on their expertise.

Q: Do you rely on automation to help with sample handling and storage?

A: We mostly use manual sample preparation, because we work with so many types of samples, on many different projects. The protocols tend to be different for every sample type, which makes it difficult for us to automate. For a large clinical study that we did years ago, we did do some automated sample preparation. Sample handling and all the different steps in sample preparation are equally important. They have to be done in exactly the same way each time to get accurate results. A study done using matrix-assisted laser desorption/ionization time of flight (MALDI-TOF) showed that even freezing and thawing of serum samples could give different results. All of our samples are manually identified and not bar-coded. Along with sample handling and sample preparation, we also keep a very close eye on the performance of the analytical instruments and on the data analysis. We spend a lot of time doing routine quality control using protein digests or samples that have been well-characterized, to check the performance of both the HPLC and MS instruments. Every three to six months, our instruments have to be shut down for routine cleaning and maintenance. We can't be sloppy about anything.

Q: What are some of the resources that you rely on for help or guidance?

A: Studies done by research groups like the iPRG and expert advice offered by the ABRF have been very helpful in learning how to do things and identifying things that we should pay attention to. With sample preparation, we often turn to colleagues for help. For data analysis, the software that we typically use has excellent online resources and web-based tutorials. If we encounter problems or if we need features that are nonexistent, then we contact the companies or the researchers who have made the tool available, and they are often very responsive. Sometimes we write the software ourselves, if there is nothing publicly available.

Thomas Neubert received his BS in biology from Georgetown University and his PhD in immunology and infectious disease from Johns Hopkins University. He then did postdoctoral work in the labs of Dr. James B. Hurley at the University of Washington and Lubert Stryer at Stanford University. After three years as senior biochemist at Fournier Pharma GmBH in Heidelberg, Dr. Neubert joined the Skirball Institute at the New York University School of Medicine in 1998, where he is now professor of cell biology and director of the NINDS-funded NYU Protein Mass Spectrometry Core for Neuroscience. His research focuses on development of new methods for protein analysis by mass spectrometry and the study of cell signaling and posttranslational modification of proteins, mostly in neurons.

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MICROPLATE READERS

ESSENTIAL INSTRUMENTATION FOR THE LIFE SCIENCES

by Angelo DePalma, PhD

The transfer of standard "test tube" chemical, biochemical, and live-cell assays to microplate formats boosted scientists' ability to run large-scale, replicative experiments in many different formats. Of these, live-cell assays have arguably been the most challenging.

Researchers are becoming more interested in converting their endpoint cell-based assays into live-cell kinetic experiments. "Live-cell imaging is preferable because you can quantify individual cell responses, whereas if you're just using the optics in a microplate reader, you're measuring responses from populations of cells," says Peter Banks, PhD, scientific director at BioTek Instruments (Winooski, VT). Toward that end, microplate reader hardware requirements for live-cell experiments depend on the biological events being measured. "Some cellular responses are fast, over in seconds, while others may extend to days or weeks," Banks continues.

For example, calcium flux induced through G-protein-coupled receptor activation lasts just a few minutes and typically peaks after 30 seconds. The experiment is usually conducted by adding the stimulus directly to cells that have been pretreated with a fluorescent dye that detects calcium ion production. "This requires injectors that deliver the stimulant, followed by rapid detection," Banks says.

But many kinetic experiments related to wound healing, cell viability, or cell proliferation can take hours or even several days. These, according to Banks, demand maintaining temperature and gas composition within physiologic ranges. "You need a reader that maintains cell health for the duration of the experiment, to maintain the appropriate phenotype for long enough for cells to migrate or proliferate."

Several vendors, including BioTek Instruments, produce systems that work with microplate readers to maintain temperature, humidity, and carbon dioxide levels within ranges that promote cell health. For example, BioTek's BioSpa™ 8 Automated Incubator links readers and imagers with washers and dispensers for up to eight microplates.

"BioSpa shuttles plates from the incubator to the reader, and is suitable for kinetic experiments extending for several days or even weeks," Banks says. "After reading, plates return to the BioSpa, where they're maintained under optimal conditions."

Unlike experiments involving fast kinetics, plates stored in incubators for long-term assays don't require instantaneous injection of reagents or stimuli. In that situation, plates can be treated by robotic transfer to conventional liquid handling systems, which also allow media exchanges for complete walk-away automation.

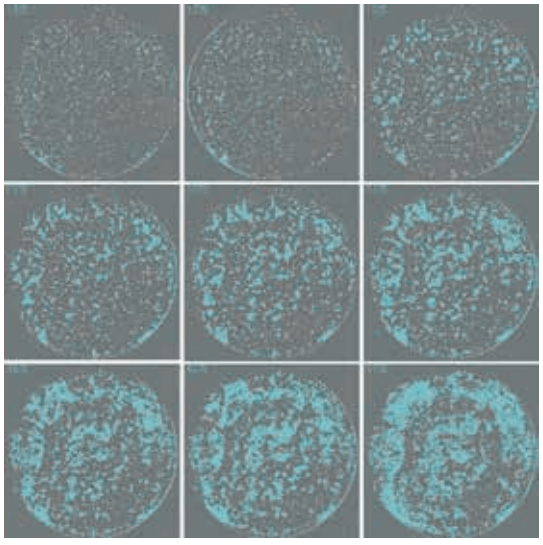
Go with the glow

A paper appearing in the summer 2017 issue of *Drug Target Review* (http://bit.ly/2waJpio) described a technique for conducting the cell-based assay that is arguably of greatest significance in commercial cell culture and drug screening: cell viability. Teaming with Sheraz Gul of the Fraunhofer Institute (Hamburg, Germany), Thermo Fischer scientist Adyary Fallarero (Vantaa, Finland) used the company's Varioskan™ LUX Microplate Reader with Promega's CellTiter-Glo Luminescent Cell Viability Assay, which quantifies viability based on levels of cellular ATP. The readout from CellTiterGlo is a "glow-type" luminescence that is proportional to ATP levels, and therefore the number of living cells.

Luminescent signals in cell-based assays fall into two categories: flash chemiluminescence, which is rapid and short-lived, and glow-type luminescence, which lasts for minutes or hours. Which type you see depends on the substrate and the enzyme used to generate the signal.

Previously, a Thermo Fisher group had demonstrated the capabilities of Varioskan LUX with a Prestoblue™ cell viability assay, LanthaScreen activity FRET assay, the GeneBlazer assay for G-coupled protein receptors, and two other glow-luminescence tests—one for signal transduction, another for protein-protein interactions.

The Fraunhofer-Thermo collaboration examined the effect of a standard drug compound library on the viability of HEK293 cells, a human kidney epithelial line. Cells were plated into a 384-well plate, incubated, and treated with the compound library at a 10 micromolar concentration.



▲ *A431 human epithelial cancer cells grown in a 96-well plate—blue overlay highlighting cell-covered areas illustrates continuous increase in cell number.*

The assay showed a correlation between luminescence and cell viability of 0.99 when normalized against standard negative and positive controls. As expected, approved drugs among the library compounds showed viability above 75 percent, suggesting that this assay might be used as an initial screen in a "go/no-go" preclinical setting to weed out potential drugs that are highly toxic.

Fortunately, the nature of such "endpoint" cell-based assays allows labs to use their existing plate readers and incubators with no special equipment or adaptation. "All the culturing steps are run inside an incubator," Fallarero tells *Lab Manager* magazine. "When it's time for a measurement, we add the colorimetric, luminometric, or fluorescence probes to the cells, and measure the readout with a Thermo Scientific Varioskan LUX reader. That's because the assay-related steps, which last from minutes to several hours, are often faster than the culturing steps." Endpoint assays are used to measure cytotoxicity, apoptosis, enzymatic activities, and cellular events such as membrane depolarization or ion fluxes.

Overcoming variability

Cell-based assays show higher variability than standard biochemical assays do. "Especially for live-cell assays, but also for endpoint assays with cell lysates," notes Siegfried Sasshofer, director of marketing for detection products at Tecan (Salzburg, Austria). "Reproducibility is a top challenge, because cells tend not to be as consistent or homogeneous as biochemical solutions."

Tecan's (Salzburg, Austria) Spark® microplate reader incorporates features and functions for cell-based assays, plus built-in cell imaging for automated cell counting and viability analysis in slides, and bright field imaging and automated confluence assessment in microplates.

Consistency and reproducibility issues plague science, particularly biological experimentation on which so much health-related research is based. For assays involving living cells, achieving consistency used to require showing up every few hours in the lab, removing cells from incubators, taking a reading, and returning cells to their optimal environment—the analog of "sneaker networks" before computer connectivity became commonplace.

"That would be most inconvenient for experiments that took place overnight or over weekends," Sasshofer says. "Hence the premium today's laboratories place on walk-away automation."

Tecan's new Spark microplate reader controls temperature, carbon dioxide, oxygen, and also humidity, which limits the need for human intervention.

For many assays involving adherent cells, investigators greatly benefit from normalizing the detection signal to the confluence level—that portion of the microwell that is covered by cells. Otherwise, researchers would not know whether an increase in signal was due to the event under study or simply an increase in attached cells.

How does automated handling and environmental control in a microplate reader compare with these operations conducted manually? One would think that dedicated incubators should do a better job.

Sasshofer says the environmental control in the Spark reader instrument is more than adequate for typical experiment duration. "The advantage over manual plate manipulation is that cells, particularly sensitive cells like stem cells, are not shocked on being removed from the incubator and placed on the reader. You might see a difference over the course of several weeks, or for special cells, but for the majority of live-cell assays of up to three days, Spark works as well as a standard incubator."

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WHAT DO **FLOW CYTOMETER** USERS HAVE TO SAY?

Flow cytometry is a powerful technology that allows researchers and clinicians to perform complex cellular analysis quickly and efficiently by analyzing several parameters simultaneously. The technique, whereby cells suspended in a stream of fluid are passed through an electronic detection apparatus, is used for cell counting, cell sorting, and biomarker detection, among other applications.

Research applications of flow cytometry, according to survey respondents:

Immunophenotyping	**45%**
GFP and RFP Detection	**39%**
Cancer	**32%**
Stem cells	**32%**
Cell proliferation	**32%**
Cell cycle analysis	**16%**
Apoptosis	**16%**
Microbiological applications	**16%**
Marine sample analysis	**6%**
Other	**6%**

Most common problems users experience when using their flow cytometer:

Low event rate	**50%**
No signal/weak signal intensity	**39%**
Two or more cell populations observed when there should be one	**32%**
High side scatter background	**29%**
High background/high percentage of positive cells	**21%**
High signal intensity	**14%**
High event rate	**4%**

Factors that would help users overcome their flow cytometry challenges:

Newer equipment	**43%**
Better training	**39%**
Better technical support	**36%**
Improved maintenance	**29%**
Newer accessories	**29%**
More staff	**21%**

TOP 5 QUESTIONS

You Should Ask When Buying a Flow Cytometer

1. What type of information can you obtain in terms of cell-based assays at the level of individual cells?
2. How does the company's technology improve your level of confidence in flow data?
3. How does the learning curve of the instrument's software compare to competitive offerings?
4. Will you be able to perform assays on this instrument without extensive experience?
5. Can the company provide some key differentiators regarding their system(s)?

ONE OF THE MOST EXCITING APPLICATIONS

for flow cytometry, as reported by users:

Immunophenotyping

Immunophenotyping is a technique used to identify various cell populations. Antibodies identify cells by detecting specific antigens expressed on the cell surface, in the cytoplasm or the nucleus of the cells.

For more information on flow cytometry, visit www.labmanager.com/tag/flowcytometry

LYO-WORKS™ OS POWERS NEW FREEZONE® FREEZE DRYERS

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You can trust Labconco freeze dryers to be reliable. Some of them have been hard at work in labs around the world for more than forty years. You can trust the newest FreeZone Freeze Dryer to be smart, too. It helps you optimize sample quality with Lyo-Works™ OS. The Lyo-Works operating system handles all of your lyophilization programs and data.

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The lyophilization process will never change. But now freeze dryer controls make the process quicker and more reliable.

Stay connected

Your samples are valuable, and so is your time. Since lyophilization can take days, it's reassuring to know the status of your sample when you're not in the lab.

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If your vacuum pump fails, it can be expensive. Pump maintenance can be a pain. The FreeZone protects your pump with its auto start-up, vacuum break valve, and patented drain line sensor.

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Data collection & visualization

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pH METERS

FINDING THE RIGHT ELECTRODE IS KEY

by Erica Tennenhouse, PhD

Measuring the acidity or alkalinity of an aqueous solution is a simple task for most labs. But other sample types can pose unique challenges that require special pH measurement considerations.

Non-standard samples

"One of the bigger issues we come across is measuring the pH of soil," says Dave Masulli, senior applications engineer at Hanna Instruments (Woonsocket, RI). Soil can be tricky to deal with because there are a number of ways one can prepare their sample, and a high risk of the electrode becoming contaminated. Measuring pH in foods such as meat or cheese, says Masulli, can also be challenging because of the fats and oils present.

According to Pamela Millett from HORIBA Scientific (Irvine, CA), the most difficult samples for measuring pH are those that are very small, viscous, or acidic. To that list, Beth Britt from Mettler Toledo (Columbus, OH) adds samples containing Tris buffers—because these buffers are reactive with one of the components of a pH electrode, one must specially design an electrode to ensure that interactions do not take place, she explains.

"Pretty much anything that's a simple aqueous solution is very easy to measure, but as you start to add more components to that aqueous solution, those components can have unanticipated effects," says Britt.

Anatomy of pH measurement

pH measurement systems consist of three main components: the meter, which measures electrode voltages and displays the results; the electrode, which interacts with the sample; and the reference electrode, which delivers a constant output regardless of the activity of the hydrogen ion. "The most important piece of it for matching the application is really the electrode," says Britt, who notes that electrodes can cross over into different meters.

The right electrode

Some electrodes are designed with tougher sample types in mind. For instance, because oily samples make it hard to get decent electrical contact between the pH electrode and the solution, they require a special kind of junction that lets out a lot of electrolyte solution, says Britt.

Masulli would also opt for an open electrode junction system when analyzing soil samples, to avoid having the electrode junction clog up. "Other things we can do [for soil analysis] include using a pointed electrode tip to allow for direct soil measurements, which definitely cuts down a lot of the sample prep and makes it easier for customers to get the job done," he says.

For food analysis, Hanna Instruments offers electrodes that have stainless steel blades at the end. "They allow you to take a direct measurement without having to blend a piece of cheese and then filter and measure the supernatant," says Masulli. "It makes it really easy for people who may not have technical expertise or the equipment to process samples."

Then there are electrodes that are ideally suited to more viscous liquids, says Millett. These "allow more of the internal solution of the pH electrodes to bleed into the sample, giving it the ionic activity it needs for a good measurement of viscous fluid."

As an example, Millett describes HORIBA's flex sensor technology, which can handle a wide range of sample types, including very small samples, liquid samples, and solid samples.

The recent focus for Hanna Instruments has been on expanding its HALO Bluetooth electrodes—a line of electrodes that hook up to Android or iOS devices, allowing the user's phone to function as a full-fledged pH meter. They offer a variety of these electrodes for specific applications, including food, wine, and agriculture, says Masulli.

Erica Tennenhouse, *technology editor for Lab Manager, can be reached at etennenhouse@labmanager.com or by phone at 647-500-7039.*

FOR ADDITIONAL RESOURCES ON pH METERS, INCLUDING USEFUL ARTICLES AND A LIST OF MANUFACTURERS, VISIT WWW.LABMANAGER.COM/PH-METERS

SHAKERS

THE MANY WAYS TO SHAKE SAMPLES

by Mike May, PhD

A few decades ago, every scientist shook samples by hand. But today's scientists can choose from a wide range of shakers that use all kinds of motions. When shopping for the right shaker, there are many factors to consider; as the rock band Genesis would say, there's an "ocean of motion."

According to Jayne Bates, technical support manager at Cole-Parmer (Stone, United Kingdom), the most popular motion is orbital shaking followed by a rocking motion. "Orbital shaking is used for culture and growth of a number of microorganisms in a variety of different vessels," she says. These shakers can stand alone or be part of an incubator, to keep the cells at the right temperature as they shake. Cole-Parmer makes a range of orbital shakers.

"Given the wide range of shaker motions, how does a scientist know which kind to purchase?"

A given application often works best with a specific shaker motion. For example, Bates says, "Rockers are used in molecular biology and biochemistry labs for washing gels and membranes and also for applications like binding assays and hybridizations." Various manufacturers, including VWR (Radnor, PA), make rocking shakers.

Although customers who shop for shakers at Cole-Parmer tend to buy orbital and rocking shakers, scientists can select from other options.

Other options

One available motion resembles the by-hand shaking mentioned above. Scientists use these hand-motion shakers for various applications, including DNA extraction.

Instead of a "hand-shake approach," wrist-action devices from Burrell Scientific (Pittsburgh, PA) swirl a sample. Daniel Snow, director of laboratory services at the University of Nebraska Water Sciences Laboratory in Lincoln, says that a wrist-action shaker is what he uses the most. When asked about the best applications for this shaker motion, he says that they include solvent extraction and equilibration.

Beyond hand shaking or swirling samples, you can slosh them with a reciprocating-motion shaker that goes back and forth. Troemner (Thorofare, NJ), for one, makes such shakers, which can be used in many different testing procedures. Some shakers combine orbital and reciprocating motions in one device, making them suitable for a variety of applications.

For delicate samples, some scientists prefer a rotating motion, which comes from devices made by Stuart (Stone, UK) and other vendors. These platforms let you pick the speed of rotation, and some even offer an angular adjustment.

Picking your motion

Given the wide range of shaker motions, how does a scientist know which kind to purchase? Bates gives us a few suggestions.

First, you "need to know how vigorous the mixing needs to be," Bates says. "This will determine the type of motion." For example, orbital, reciprocating, and wrist-action devices all can vigorously shake a sample.

Second, the type of holder for the sample must be considered. "For example, a tube roller, although giving a gentle rocking motion, is not suitable for containers with fragile gels inside, which are better placed on a rocking platform," Bates explains. "Likewise, tubes need to be held in place while mixing or shaking to prevent them from moving around."

So, with a little bit of planning, scientists can "swim through the ocean of motions" and find the right shaker for the tasks in their lab. The variety of platforms available ensures that one will probably be just right for any job and provide the control and repeatability that a particular experiment requires.

Mike May *is a freelance writer and editor living in Texas. You may reach him at mike@techtyper.com.*

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WHAT DO PARTICLE SIZE ANALYZER USERS HAVE TO SAY?

Particle size measurement has become a critical application for chemicals, foods, paints, cosmetics, coatings, materials, and many other industries. Particle size, shape, density, and distribution affect the physical properties and chemical behaviors of all products comprised of particles or that use them as ingredients: The size of stationary phase particles affects chromatography retention time, pigment particles dictate hue and finish in paints, and physical dimension imparts mechanical, optical, and electronic properties to nanomaterials. Within critical size domains from nanometers to about ten microns, the physical state can be as important as chemical composition.

Particle sizing techniques used by survey respondents:

Laser Diffraction	**40%**
Dynamic Light Scattering	**38%**
Sieving	**29%**
Automated Imaging	**24%**
Dynamic Imaging	**22%**
Sedimentation	**13%**
Electrophoretic Light Scattering	**4%**
Electrozone Sensing	**4%**

For respondents engaged in purchasing a new particle size analyzer, the reasons for these purchases are as follows:

Replacement of aging system	**50%**
Addition to existing systems, increase capacity	**22%**
Setting up a new lab	**10%**
First time purchase	**10%**

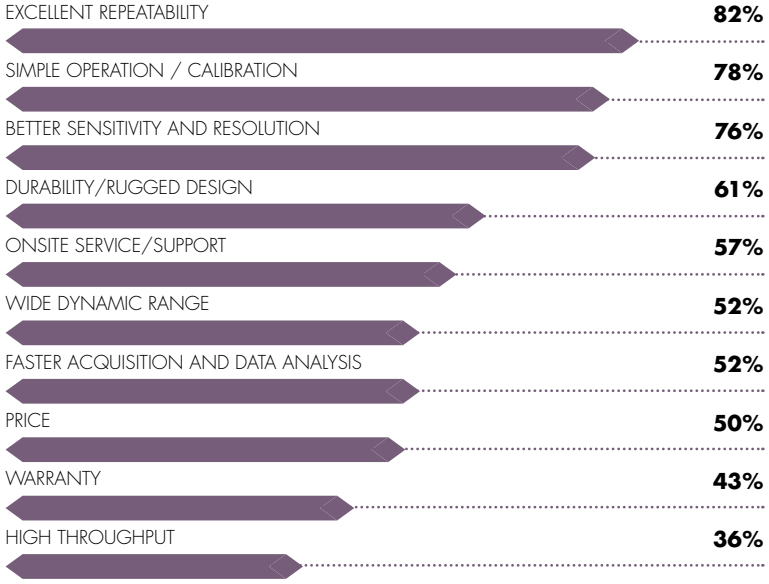
TOP 6 QUESTIONS

You Should Ask When Buying a Particle Size Analyzer

1. What is the size range you need to measure? Unfortunately, no one technique can measure all possible particle sizes, so the range needed will narrow the potential systems which can be used.
2. What exactly do you want to measure and why? Particle analyzers use many different techniques to arrive at measurements. In order to figure out what technique will work best for your application, you need to define what you are trying to measure and why.
3. Are you trying to characterize different particle types in a single sample?
4. In what "state" should the measurements be made? In many cases, measurement of the particles in the "native state" may not be possible.
5. Is measuring the count or concentration (two different measurements!) of the particles along with size/shape important? If knowing an absolute particle count, or a particle concentration is important, then some techniques will be eliminated immediately.
6. How easy is it to generate reliable data? Think about your users and ask what, if any, specific expertise is required for system set-up and routine use. Then, ask to make a measurement to assess this during the selection process.

TOP 10 FEATURES/FACTORS

Respondents Look for When Purchasing a Particle Size Analyzer:



For more information on particle sizing, including useful articles and a list of manufacturers, visit www.labmanager.com/particle-sizing

WHAT DO VISCOMETER USERS HAVE TO SAY?

Many industries measure viscosity, though the biggest user is the quality control department utilizing single-point measurement. Research scientists also use viscometers to see how a material reacts to being sheared. The task at hand determines the kind of viscometer to use—different viscometers measure different magnitudes of viscosity and different changes in it. According to one expert, the most important factor to consider when buying a viscometer is robustness, even if users have to give up some sensitivity.

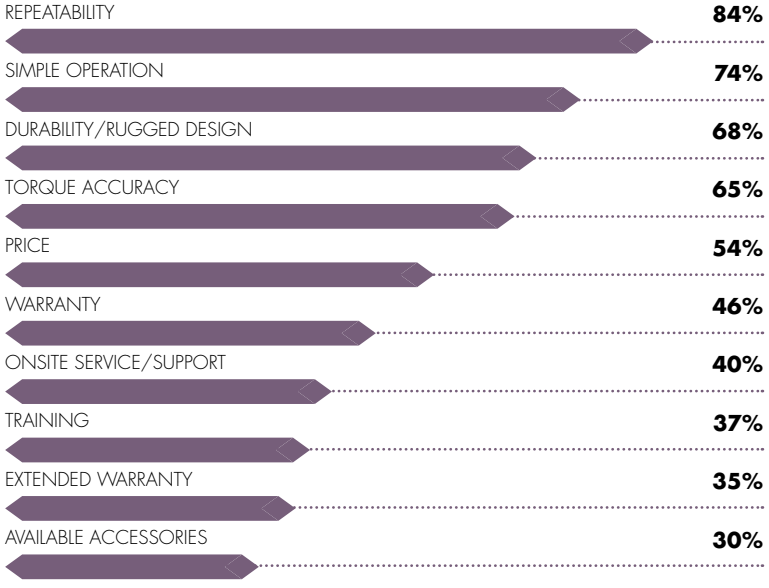
TOP 6 QUESTIONS

You Should Ask When Buying a Viscometer

1. What kind of temperature control and spindle rotational speed control does the instrument offer? Temperature is critical, since viscosity generally rises as a fluid cools. Spindle rotation may also affect viscosity.
2. What range of accessories (ex. sample holders) does the company offer for the instrument?
3. How easy to use is the viscometer? Since most users nowadays aren't experts, an easy-to-use instrument is probably the best fit for most labs.
4. What are the sizes of the samples you'll be working with? This may be an issue when analyzing very expensive materials such as drugs or proteins and cost of ownership is also important for high-volume applications.
5. What is the instrument's measurement range? If you're analyzing petroleum, from crude oil to gasoline, do you want to change out the capillary for each measurement, or use something that works all the way through?
6. What kind of service and support does the company provide?

TOP 10 FEATURES/FACTORS

Respondents Look for When Purchasing a Viscometer:



Viscometer types used by survey respondents:

Rotational Viscometer	84%
U-Tube / Ostwald Viscometer	27%
Falling Ball Viscometer	6%
Falling Piston Viscometer	2%
Rectangular Slit Viscometer	2%
Vibrational Viscometer	0%

Frequency of viscometer usage by survey respondents:

Several times daily	41%
Several times each week	23%
Two to three times a month	19%
Less than once a month	17%

Nearly 51% of respondents are engaged in purchasing a new viscometer. The reasons for these purchases are as follows:

Replacement of aging system	45%
Addition to existing systems, increase capacity	26%
Setting up a new lab	5%
First time purchase	5%
Other	19%

For more information on viscometers, including useful articles and a list of manufacturers, visit www.labmanager.com/viscometers

TECHNOLOGYNEWS

ANALYTICAL

Micro-Volume Spectrophotometer

NanoVue Plus

- Biochrom offers a comprehensive installation and IQ/OQ documentation package for the NanoVue Plus
- Wavelength accuracy and wavelength repeatability are just some of the specifications measured using NIST traceable standards following both European and United States pharmacopeia guidelines
- Test procedure includes a step by step procedure to ensure that the hardware and software are installed in a controlled manner, and more

Biochrom www.biochromspectros.com

Nano-Flow UHPLC System

nanoElute®

- Along with the new Proteoform Profiling™ 1.0 solution, aims to bring enhanced ease-of-use to nano-spray mass spectrometry, which is essential for label-free discovery workflows on intact protein mixtures
- Takes advantage of the performance of Bruker's impact II and ETD-enabled maXis II UHR-QTOFs
- These UHR-QTOFs deliver accurate and reproducible proteoform profiles from complex intact, undigested protein mixtures

Bruker www.bruker.com

Fat Analyzer

ORACLE

- Winner of the IFT17 Food Expo Innovation Award
- Based on a very recent breakthrough in NMR technology
- The first ever rapid fat analyzer that requires absolutely no method development and can analyze fat in any unknown food sample with reference chemistry accuracy and exceptional repeatability
- Allows for rapid testing regardless of amount of fat or matrix

CEM www.cem.com

Benchtop NMR Analyzer

MQC+

- Designed for the measurement of oil, water, fluorine, and solid fat in a variety of samples in a wide range of industries
- Replaces wet chemical analysis, which uses hazardous chemicals, and allows the measurement of more samples much faster
- Does not destroy the sample being measured
- Available in three models

Oxford Instruments www.oxford-instruments.com/mqc

Chiral LC/SFC Selector

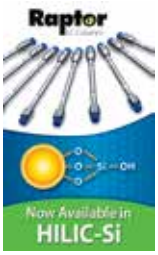
Lux 5µm i-Amylose-1 & Lux 3µm i-Amylose-1 media

- Combine with six Lux coated chiral stationary phases (Amylose-1, Amylose-2, Cellulose-1, Cellulose-2, Cellulose-3, and Cellulose-4) to deliver a wide and complementary range of enantioselectivity for even the most difficult chiral separation projects
- Lux 3µm i-Amylose-1 is ideal for LC/SFC analytical work and chiral screening
- Lux 5µm i-Amylose-1 can be used for analytical and purification work as it is available in pre-packed Phenomenex Axia™ preparative columns

Phenomenex www.phenomenex.com

HILIC-Si Columns

Raptor



- Simplify the switch to HILIC
- Deliver rugged performance, provides SPP column speed for faster analyses than traditional FPP silica columns, and retains polar compounds without ion-pairing reagents
- Fully reliable, efficient, and selective with LC-MS compatible mobile phases
- Make the analysis of polar compounds fast, easy, and MS friendly

Restek www.restek.com/raptor

Membrane Chromatography Cassettes

Sartobind® Cassettes

- This convenient, pod-like modular system has been developed for commercial applications in both capture and polishing
- Offer the same flow path, bed heights (4 and 8 mm), and void volume ratios as Sartobind® capsules, and are compatible with Q, S, STIC PA, and phenyl ligands
- Setup can be accomplished within minutes, even at manufacturing scale

Sartorius Stedim Biotech www.sartorius.com

Data Independent Acquisition Technology

SWATH® Acquisition

- Allows the simultaneous and comprehensive identification and quantification of virtually every detectable compound in a sample, from a single analysis
- Offers high reproducibility across multiple samples with wide dynamic range
- Enables the creation of a permanent digital record of quantitative MS/MS data for the entire sample
- Widely used today in the industrialization of proteomics research and can now bring significant advantages to other fields

SCIEX https://sciex.com

METROHM'S NEW ECOIC: INTELLIGENT ION CHROMATOGRAPHY FOR COMMON ION ANALYSIS

Eco IC is Metrohm's newest entry-level ion chromatography system that focuses on the essentials of the technology while maintaining the quality, experience, and reliability inherent to all Metrohm products.

System robustness, reproducibility of results, and ease of use are the benefits that our customers consistently mention, when talking about their experience with our instruments. All of the features responsible for these benefits are available in the Eco IC.

The Eco IC's design makes it perfect for the routine analysis of anions, cations and polar substances, and delivers it in one small, efficient and powerful package. It comes with all components needed for ion chromatography analysis: suppressor, conductivity detector, 36-sample auto sampler, and software are all included.

Typical analyses include:

- Anions: chloride, nitrate, and sulfate
- Cations: sodium, potassium, calcium, and magnesium

Self-monitoring and control: Ion chromatography with intelligence

One hallmark of all Metrohm Ion Chromatographs is the ability to monitor their operation. Smart monitoring of several system components means that the Eco IC alerts the user on key system health parameters, such as number of injections, working hours, service intervals, and background conductivity. Eco IC actively prevents user errors such as damage to the column caused by incorrect flow rates or excessive back pressure.

This intelligence extends to the chromatography software itself. If an injected sample falls outside the calibration range, the Eco IC and its software is programmable, and can check and validate each result after each run – automatically.

Straightforward software control and data management

Our MagIC Net ion chromatography software controls the Eco IC and features a graphical user interface with drag-and-drop functionality, enabling straightforward, intuitive operation.

Warranties, Responsive Expertise and Support

With an IC system from Metrohm, you will benefit from exceptional support and warranties:

Local support from Metrohm service technicians

Industry-leading warranties: 3 years for instruments, 10 years for the anion suppressor, 5 years software support, 10 years spare part availability

Eco IC offers:

- **Small footprint for water analysis and educational institutions:**
  Analyze anions, cations, and polar substances.
- **Everything you need at an attractive price:**
  Software, suppressor, and detector included.
- **Swiss-quality:**
  High-quality, robust, and durable hardware and components.
- **Optional automation and Inline Ultrafiltration:**
  Save time and reduce costs with automated analysis.
- **Intelligent IC:**
  Intelligent components control and monitor processes and prevent errors.

Metrohm

PRODUCT SPOTLIGHT

SMALL FOOTPRINT, BIG LC-MS PERFORMANCE

NEW TRIPLE QUAD INSTRUMENT HAS 70% SMALLER FOOTPRINT BUT EQUIVALENT PERFORMANCE TO LARGER SYSTEMS

In early June, Agilent introduced the newest member of its family of triple quadrupole liquid chromatography mass spectrometers at the American Society for Mass Spectrometry Conference in Indianapolis, Indiana. The Ultivo triple quad is a transformative approach to LC-MS that integrates several hardware and software innovations designed to deliver even more improved business results for users.

Ultivo is optimized to address the food and environmental routine testing segments employing triple quad LC-MS systems for quantitative analyses. The system delivers robust performance, superior uptime, and easier serviceability, in a footprint that is 70 percent smaller than previous instruments. Scientists can now significantly increase their analytical throughput without having to increase the size of their existing laboratories.

"We are a production lab experiencing some significant growth, so the ability to place more instrumentation in the same footprint in the lab is important," said Johnny Mitchell, president at ESC Lab Sciences (Nashville, TN). "Without that ability we would be faced with some expensive construction costs to increase the size of our facilities."

In addition to its small size, Ultivo provides reproducible, reliable assays that result in exceptional performance in complex matrices. Greater ion transmission efficiency leads to optimized sensitivity; and improved, intelligent diagnostics use intuitive readbacks that can quickly identify issues, ensuring optimum uptime.

"Ultivo provides a revolutionary new 'fit for purpose' triple quad LC-MS, that is smaller than could've been imagined, yet delivers the superior performance usually associated with much larger instruments," said Monty Benefiel, vice president and general manager of Agilent's Mass Spectrometry Division. "We are excited by our customers' reactions so far, and expect that Ultivo will dramatically change the LC-MS landscape now, and for years to come."

For more information, visit www.agilent.com

Flow Modulator for GCxGC

INSIGHT™

- Designed for routine comprehensive two-dimensional gas chromatography (GC×GC)
- Will broaden the uptake and appeal of GC×GC, thanks to simplified technology, which offers high performance while avoiding use of liquid nitrogen
- Helps reduce the cost of ownership for laboratories wishing to utilize the power of GC×GC
- Pared-down design fits easily inside standard GC ovens

SepSolve Analytical www.sepsolve.com/separation

Benchtop MALDI-TOF Mass Spectrometer

MALDI-8020

- Previewed at ASMS 2017
- Achieves performance specifications similar to those of larger, more expensive MALDI-TOF models but in a smaller footprint
- Improves laboratory efficiency and accelerates analysis through a newly designed load-lock system for rapid sample target introduction and a solid-state laser for fast data acquisition speeds
- Enables low-level detection of proteins, peptides, and polymers, among other analytes

Shimadzu www.ssi.shimadzu.com

Spectroradiometer

PSR-1100^f

- SPECTRAL EVOLUTION's smallest, lightest, full featured field spectroradiometer
- Features a spectral range of 320-1100nm
- Can be used with a laptop or handheld microcomputer, or as a standalone instrument with its built-in keypad and LCD display
- Suited for remote sensing and ground truthing in a very wide range of applications
- Offers NIST-traceable radiance calibration for 25° fiber optic cable

SPECTRAL EVOLUTION www.spectralevolution.com

Clinical LC-MS/MS Analyzer

Cascadion SM

- Brings together the ease of use of clinical analyzers with the selectivity and sensitivity of liquid chromatography-tandem mass spectrometry (LC-MS/MS)
- Designed for use in a variety of settings, including hospital laboratories, and to provide results for a range of clinical tests
- Can analyze multiple analytes with greater specificity, and reduced interference and cross-reactivity than alternative methods

Thermo Fisher Scientific thermofisher.com/Cascadion

Hybrid Quadrupole Orbitrap Mass Spectrometer

Q Exactive HF-X

- Designed to quickly and consistently produce superior data quality for challenging workflows across life science research and biopharma applications
- Aims to provide sensitive, accurate and reproducible analyses of highly complex samples
- Delivers extremely fast and accurate mass analysis, plus two-to-three-fold sensitivity improvements, delivering the same number of protein identifications in half of the time required for previous models

Thermo Fisher Scientific thermofisher.com/asms

Triple Quadrupole Mass Spectrometers

TSQ Altis & TSQ Quantis

- Offer excellent robustness and sensitivity for demanding targeted quantitation assays
- The TSQ Altis offers sensitivity, selectivity and speed while providing the analytical flexibility and reproducibility for demanding applications
- The TSQ Quantis Triple Stage Quadrupole mass spectrometer is designed to be a quantitative workhorse, supporting reliable workflows that combine ease of use with the highest possible data

Thermo Fisher Scientific thermofisher.com/Altis-Quantis

BASIC LAB

LED Light Bars

- BINDER now offers LED light bars as optional accessories for incubators (KB Series), refrigerated incubators (KT Series), and humidity test chambers (KBF Series)
- These aluminum strip lights, available in lengths of 11.8", 19.6," and 35.4", are water-resistant and can be operated between -5°C and 60°C
- The high quality white light LED modules provide an illumination of 600 lux

BINDER www.binder-world.us

Ultrasonic Flow Meter

ES-FLOW™

- Designed to measure tiny volume flows from 4 up to 1500 ml/min with high precision, high linearity, and low pressure drop, using ultrasound in a small bore tube
- Liquids can be measured independent of fluid density, temperature, and viscosity
- Thanks to the combination of a straight sensor tube with zero dead volume, the flow meter is self-draining

Bronkhorst www.bronkhorst.com

Bioprocess Control Station

BioFlo® 120

- Eppendorf's latest bench scale fermentor/bioreactor system for research and development
- Capable of microbial fermentation as well as mammalian cell culture applications with a single platform
- Features an extensive range of glass and BioBLU® Single-Use Vessel options (250 mL – 40 L)
- Universal connections for digital Mettler Toledo® ISM and analog sensors make it easy to monitor a variety of critical process parameters

Eppendorf www.eppendorf.com/BioFlo120

Planetary Mill

PULVERISETTE 6 *premium line*

- Features two work stations
- Ideal for fast wet and dry grinding of hard, medium-hard, soft, brittle and moist samples
- Also suitable for mechanical alloying, mixing and homogenizing of larger sample quantities with reliable results down into the nano range
- Offers absolutely secure automatic clamping of bowls

FRITSCH www.fritsch-us.com

Conductivity Meter

Model 2100

- Now available in East Asia through a distributor agreement with Titan Technologies, K.K. of Japan
- This meter and its associated line of high-accuracy smart probes can measure liquid conductivities ranging from 10^{-3} S/cm, typical of low concentration aqueous solutions, down to 10^{-15} S/cm, typical of low concentration solutions in non-polar solvents
- Eliminates the need to correlate multiple meters and swap and calibrate multiple probes

ILIUM www.iliumtechnology.com

Field Emission Scanning Electron Microscope

JSM-7900F

- A uniquely flexible platform that combines the ultimate in high resolution imaging with unparalleled nanoscale microanalysis
- Excels in lightning fast data acquisition through simple and automated operation
- Applications include imaging and analysis of metals, magnetic materials, semiconductors, ceramics, medical devices, and biological specimens
- High sensitivity BE detector provides excellent performance at low accelerating voltages

JEOL USA www.jeolusa.com

Automated Solid Evaporator System

AQS-22010AS

- This automated Karl Fischer titrator system combines the AQ-2200 coulometric titrator or AQV-2200 volumetric titrator with the evaporator EV-2010
- Can save valuable bench space with its extremely compact and upright design
- The sample changer can hold up to 10 vials at the same time, and up to 99 samples can be run by removing the finished sample and adding a new one

JM Science www.jmscience.com

Digital Microscope

VHX-5000

- Eliminates the need for focus adjustments, greatly speeding up measurements
- With the push of a button, an optimized view of the target is produced in as little as one second
- Has a depth-of-field 20 times greater than traditional microscopes, with high-resolution optics and software that captures and optimizes images automatically

Keyence www.keyence.com/kennametal

Microscope

BX53

- With an LED illuminator equivalent to a 100-watt halogen lamp, this microscope delivers outstanding brightness and true-to-life images
- Ergonomic design and ease of use make it an ideal system for clinical laboratories
- High-luminosity LED illuminator enables researchers to clearly see the purple, cyan, and pink dyes that are commonly used in life science applications

Olympus www.olympus-lifescience.com

Nitrogen Generator System

Infinity XE 50 Series

- Unveiled at the 65th ASMS Conference in Indianapolis, IN
- Designed to cater to numerous applications across a typical laboratory, from a single source solution
- Provides a variable flow of nitrogen gas ranging from 11 to 432 liters per minute and at purities up to 99.5%
- New features include purity monitoring with optional failsafe shutdown and eco mode

Peak Scientific www.peakscientific.com

Freeze Dryer

LyoCapsule™

- Delivers results comparable to larger R&D freeze dryers
- Enables a Quality by Design (QbD) approach to cycle development even when materials are highly expensive or limited in quantity
- Small chamber incorporates a unique cylindrical inner chamber, or "capsule," to hold the vials and utilizes wall temperature control to ensure that edge vials dry under the same process conditions as center vial

SP Scientific www.spscientific.com

CHEMICALS, KITS, & REAGENTS

RT-PCR Assay Kit

ZDC Multiplex

- Allows researchers to simultaneously screen samples for Zika (ZIKV), dengue (DENV1, DENV2, DENV3, DENV4), and chikungunya (CHIKV) arbovirus RNAs
- Approved for Research Use Only and is currently available only outside the U.S.
- Is a one-step reverse-transcription, real-time PCR assay for the simultaneous detection and quantification of ZIKV, DENV, and CHIKV RNAs from a large range of specimen types

Bio-Rad www.bio-rad.com

Mass Spectrometric Immunoassay Kit

InsuQuant

- Incorporates all necessary reagents and consumables needed in the pre-analytical stage of the LC-MS workflow
- Designed to eliminate the need for researchers to make buffers and match reagents, thus saving resources and reducing the risk of human errors in complex protocols
- Enables advanced detection of endogenous insulin and its exogenous analogues in the tip of a pipette

Thermo Fisher Scientific www.thermofisher.com

Endotoxin-Free Plasmid DNA Isolation Kits

PureLink Expi Maxi

- Includes a simple and fast protocol for isolation
- Allows researchers to yield up to 1.5 mg of endotoxin-free, advanced transfection-quality plasmid DNA in less than 90 minutes
- Uses novel, proprietary anion-exchange membrane based columns, in combination with a vacuum-assisted workflow, to isolate advanced transfection-grade plasmid DNA in about half the time of current standard protocols

Thermo Fisher Scientific www.Thermofisher.com/Endofreeplasmid

INFORMATICS

LIMS Upgrades

Matrix Gemini

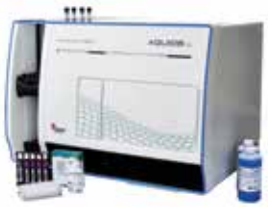
- Latest software release provides greater bulk sample registration flexibility and enhanced features for visualization and communications for users
- Include the ability to define the location of a sampling point on an image, record a screenshot with a single button, and add attachments to e-mails generated within the LIMS
- Performance improvements and security enhancements have also been incorporated

Autoscribe Informatics www.autoscribeinformatics.com

Flow Cytometry Software

AQUIOS Designer Software

- Developed specifically to handle user-defined tests in the routine lab
- Allows for the creation of customer-defined applications to be run on an instrument that combines sample preparation and flow cytometry analysis in one platform (AQUIOS Load & Go technology)
- Reduces the routine, repetitive task of having to manually mix reagent combinations



Beckman Coulter Life Sciences www.aquioscl.com

Label Automation Apps & Suites

Brady Workstation Apps and Suites

- Designed for simple, efficient, and flexible product label, wire label, and safety sign creation
- Help design custom and standard labels and signs for a wider variety of applications
- Complete line of apps and suites work seamlessly with the full range of desktop and portable printers from Brady without having to install any print drivers

Brady Corporation http://workstation.bradyid.com

Metabolomics Research & Validation Solution

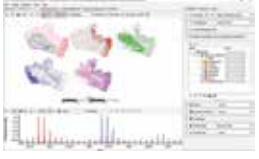
MetaboScape® 3.0

- Offers powerful new features essential for discovery metabolomics, including support for direct-injection (DI) or MALDI magnetic resonance mass spectrometry (MRMS) for high-throughput phenomics translational research and validation
- A novel algorithm called Time-aligned-Region-complete-eXtraction ('T-ReX') automatically extracts all relevant information in sample cohorts in a "region complete" manner
- Includes workflows that support evaluating high-throughput, chromatography-free DI-MRMS or MALDI-MRMS data

Bruker www.bruker.com

Mass Spectrometry Imaging Software

SCiLS Cloud & SCiLS Lab



- Now feature multi-vendor support
- SCiLS Cloud software offers web-based tools to facilitate distributed workflows, where data and analysis results can be shared, viewed, and manipulated with a web browser through secure access
- SCiLS Lab provides advanced and user-friendly solutions for data handling, visualization, and computational analysis for Bruker MALDI imaging data sets, and now also offers support for data acquired from non-Bruker mass spectrometers

Bruker www.bruker.com

Software for Applied Toxicology & Forensics

TargetScreener 3.0HR

- Includes TASQ™ 1.4 (Target Analysis for Screening and Quantitation) software to provide a unified software platform for automated screening and quantitative applications in forensic, food, and environmental safety markets
- ToxTyper 2.0E solution for routine, high-throughput forensic toxicology is also available with further improved capabilities

Bruker www.bruker.com

Clinical Outcomes Database Explorer

CODEx

- An intuitive, web-based platform
- Enables drug development teams to easily visualize, explore, analyze, and communicate content from Certara's Clinical Trial Outcomes Databases and assess a given compound's probability of success against competitor drugs
- Facilitates the effective use of information from the Certara Clinical Outcomes Databases—a collection of well-organized clinical drug efficacy and safety data from the published biomedical literature for different diseases

Certara www.certara.com

Biological & Chemical Data Discovery Solution

Reaxys Medicinal Chemistry

- More than twice as fast as any other solution
- Improves the discoverability and extraction of relevant chemistry data
- New release has undergone significant usability improvements to deliver a more streamlined and intuitive user interface
- Allows any level of user—from beginner to expert—to use the solution with ease
- Enhancements have also been made to search functionality, powered by machine learning algorithms

Elsevier www.elsevier.com/solutions/reaxys

Work Requesting & Orchestration Tool

E-WorkBook Request

- Available as a new module that runs on IDBS' E-WorkBook Cloud platform
- A Software-as-a-Service (SaaS) offering, designed to facilitate collaboration
- Built to meet scientific and R&D data management challenges, allowing easier scheduling of work and faster feedback on high-level workflows
- Optimized to work on all devices with a modern and intuitive design

IDBS www.idbs.com

Online Marketplace for Human Biospecimens

iSpecimen Marketplace

- An online, data-rich platform that connects life science researchers who need human biospecimens to the healthcare organizations that have them
- Using a powerful, multi-faceted search platform, the marketplace enables medical researchers to intuitively search millions of available human biospecimens and solves one of the research industry's biggest challenges—how to compliantly obtain quality biospecimens in a cost-effective manner

iSpecimen www.ispecimen.com

Image & Data Management Platform

Xplore

- A web-based informatics platform for drug research and biomarker discovery
- Part of Philips' computational pathology portfolio
- Provides pharma and academic researchers with enhanced search capabilities, barcode support, data visualization tools, and third party image analysis vendor integration
- Allows institutions to store clinical, image analysis, molecular and summary genomic data with research pathology whole slide images or tissue microarray (TMA) studies

Philips www.philips.com

Software Solution for Biopharma & Pharma

Active Dashboard 2

- Features significant improvements for applications in biopharmaceutical, pharmaceutical, and other manufacturing industries
- Delivering in-depth insights into process performance across the manufacturing network, managerial staff can take evidence-based proactive actions that will help to achieve better timely decisions, ensuring superior manufacturing success
- Provides real-time process information from multivariate SIMCA®-online data analysis systems

Sartorius Stedim Data Analytics http://umetrics.com

LIFE SCIENCE

Automated Pulsed-Field CE Instrument

FEMTO Pulse

- Accurately sizes fragments as large as 165,000 base pairs
- Measures samples at concentrations as low as 5 fg/µL
- Run time is about one hour compared to 16 hours with methods such as agarose based pulsed-field gel electrophoresis
- Useful for applications such as single-cell nucleic acid analysis, PCR-free preparation of NGS library preparation, bacterial artificial chromosome (BAC) clone sizing, and exosome analysis

Advanced Analytical Technologies www.aati-us.com

Infectious Disease Monoclonal Antibodies

- Binding Site has recently introduced a number of new monolclonal antibodies focused on infectious diseases, including CMV, hepatitis (A, B, C, and D), herpes, HIV, rubella, and toxoplasma
- Exhibit outstanding degrees of specificity, while demonstrating high levels of purity, extended shelf-life stability claims, and lot-to-lot consistencies
- All available in a standard-sized 1.0mg fill format, while the rest come in a 0.2mg fill format

Binding Site www.immunologicals.com

ddPCR™ Genome Edit Detection Assays

- Provide the first tests to characterize edits generated by CRISPR-Cas9 or other genome editing tools using Bio-Rad's Droplet Digital PCR (ddPCR) technology
- Users can specify their sequences and order assays through Bio-Rad's Digital Assay Site
- ddPCR empowers scientists to precisely evaluate the efficiency of their experiment in less time and at lower cost than with any other method

Bio-Rad www.bio-rad.com/digital-assays

Cell Imaging Multi-Mode Reader

Cytation™ 1

- Offers an affordable entry into automated digital quantitative microscopy along with multi-mode microplate detection
- Provides quantitative phenotypic cellular information and well-based quantitative data
- Modular architecture allows users to satisfy their current research needs, and upgrade with additional modes to suit future needs
- Digital microscopy mode includes fluorescence and high contrast brightfield channels for visualization from 1.25x to 60x

BioTek www.biotek.com

Sample Preparation System

Arcis

- Can extract DNA and RNA for downstream processes such as PCR/qPCR and sequencing in just three minutes
- University of Liverpool study results showed that the Arcis Sample Prep Kit dramatically accelerates pre-analytical sample prep without compromising the quantity and quality of genomic material
- Easily integrated into automated systems
- Extraction kit consists of a two-step protocol

Cole-Parmer www.coleparmer.com

Microfluidic Liquid Handler

MANTIS®

- Allows researchers to analyze 3–4 times as many cells and subsequently increase the power of their genetic analysis
- Dispenses precious reverse transcription and library preparation reagents as low as 100 nl, facilitating reproducible miniaturized reactions, even between users
- Allows laboratories to analyze more single cells at the same cost to their lab

FORMULATRIX www.formulatrix.com

Cell Imaging Systems

IN Cell Analyzer 6500HS & 2500HS

- IN Cell Analyzer 6500HS is a laser-based confocal imaging system, while the IN Cell Analyzer 2500HS is a wide-field cell imaging system
- With the new IN Carta software, these next-generation systems combine powerful analytics with an intuitive user interface to provide fast, quantitative results
- The 6500HS enables a wide range of high-content assays while the 2500HS is for researchers interested in performing a wide range of functions

GE Healthcare Life Sciences www.gelifesciences.com/HCA

Alkaline Phosphatase Testing System

ZymoSnap ALP

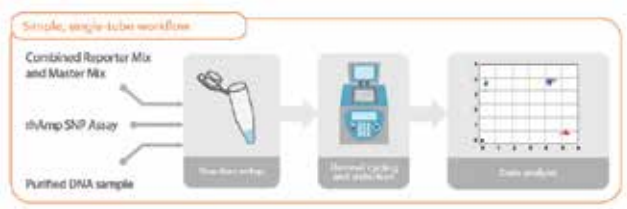
- Designed to verify pasteurization efficiency in short shelf life dairy products within just five minutes
- Has been specifically developed to offer reliable, definitive and repeatable results, even at low levels (25-100 mU/L), ensuring confidence in results
- Featuring a convenient all-in-one design and requiring only minimal equipment, the system is simple to use without specialist knowledge or testing facilities

Hygiena www.hygiena.com

SNP Genotyping System

rhAmp™ SNP

- Enables researchers to make accurate and confident SNP calls both quickly and cost-effectively
- rhAmp technology uses a unique RNase H2/DNA polymerase two-enzyme system coupled with RNA-DNA hybrid primers to eliminate non-specific amplification and primer dimer formation, which are challenges for other genotyping chemistries
- Features an easy-to-use, single-tube assay setup that is easily automated



Integrated DNA Technologies www.idtdna.com

Gel Imaging System

NuGenius+

- This cost-effective system is configured with powerful new software for generating accurate, high quality images of stain-free protein gels, in addition to DNA agarose and SDS- PAGE gels, saving scientists valuable time with their research
- Features a compact darkroom, large UV transilluminator, and UV filter
- Touchscreen-controlled by image capture software

Syngene www.syngene.com/nugenius-gel-imaging-system

SUPPLIES & CONSUMABLES

Two-Way Pneumatic Pinch Valves

NPP Series

- These air-piloted devices are designed to open or close tubes for controlling flow of liquids and gases
- Have no areas of dead volume where fluid can become trapped
- Hygienic and easy to clean and can handle whole blood and particulate matter
- Each valve comes with 12" of selected tubing
- Provide an unobstructed flow path

Clippard clippard.com/link/npp-tds

Sampling Devices

SteriWare PharmaScoops®

- Made from a variety of materials; choices include, polystyrene, polypropylene, and high density polyethylene
- Available in white, red, or blue and are manufactured in a medical cleanroom
- Manufactured using FDA, EC 1935/2004, and EU 10/2011 conforming materials and are BSE/TSE free
- Are available pre-sterilized or non-sterilized and in sizes from 30ml to 2500ml

Sampling Systems www.sampling.com

SAFEGUARDING SAMPLE INTEGRITY WITH AUTOMATED STORAGE SYSTEMS

Problem: **Almost every laboratory requires sample storage, regardless of whether the samples to be stored are chemical or biological in nature. Manual storage methods typically involve multiple sample container types stacked haphazardly across many freezers that are shared with other users as part of an ad hoc storage system. Overcrowding is an issue for users as conventional freezers take up precious lab space; and it's also problematic for the sample quality. Crowded samples can block air flow in freezers, leading to significant temperature gradients that can often degrade samples. As users rummage through the freezer to add or find their samples, they expose the entire freezer contents to warm ambient room conditions, which can further degrade samples, especially if samples are removed completely to access the far reaches of the freezer. Even if logs are maintained to track sample locations and access, there's no guarantee that the samples weren't inadvertently moved or mishandled by another user, and no documentation to track how many times the freezer contents were exposed to ambient conditions, or for how long.**

Solution: The Verso automated sample storage system (Hamilton Storage, Franklin, MA) offers complete control over environmental conditions, access, and traceability to protect sample integrity, even among shared users. Verso is controlled via a simple 'three-click' software interface, and may also be easily integrated into a LIMS system for remote management. A convenient hands-free foot switch is used to open the Input/Out (I/O) module for sample placement or retrieval. Up to 100 racks, containing a wide variety of tubes and vials, or microplates and full trays, are placed into the I/O module. Once the module is closed, a robotic shuttle moves the samples to an identification station, where the individual samples are scanned to initiate the audit trail, then moved to the designated storage location.

Verso offers storage temperatures from ambient to -20°C. All processing steps—such as identifying, picking, and storing—occur at the same temperature so that samples are not subject to freeze/thaw cycles that occur with manual storage methods. In addition, an inert gas environment (nitrogen) can be created to further assist with the most beneficial repository conditions. A wide range of system and sample reports may be automatically generated for temperature history, sample access, job history, system usage, and more, while a complete audit trail is maintained for every sample throughout its life cycle. To retrieve samples, users enter the request through the LIMS system or at the user interface. A Universal Tube Picker (Figure 1) cherry-picks multiple sample types with different diameters, and the robotic shuttle delivers the samples to the I/O module for users to retrieve, or to a hand-off arm for integration with a liquid handling system or third-party robotic system. These advanced storage and processing steps further eliminate the risk of sample degradation, and significantly reduce labor time as the processing occurs unsupervised, including overnight.

Up to 1,500 tubes/hour or 170 plates/hour may be processed from order submission to retrieval, while a priority management system allows critical picking requests to interrupt routine jobs. An optional dual tray shuttle on large models increases throughput, and optional active thawing accelerates subsequent processing steps such as pipetting or centrifuging. Verso's software includes extended security features so that samples cannot be accessed by any unauthorized users. Finally, the system is modular so that it can be expanded at any time without the inconvenience and cost associated with new equipment purchases. Automated sample storage systems such as Verso further enable sample management in the lab while eliminating the risk of sample degradation that is typical of traditional manual storage practices.

For more information, contact sales@hamilton-storage.com, or visit www.hamiltoncompany.com/samplestorage

▲*Figure 1. Verso's Universal Tube Picker allows sample picking of multiple labware types with different diameters for increased flexibility.*

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LAB MANAGER ONLINE

We look back at our web content since the August issue and look forward to what's in store for the upcoming October issue.

1 A Look at Science-Specific Crowdfunding Sites

Now that you've read the first of our crowdfunding science articles in this issue, get more information online, with a comparison of the different science-specific crowdfunding platforms we explored in this month's article. You'll also find links to the crowdfunding campaigns of all of the researchers we spoke to for both articles.

Read more at **LabManager.com/crowdfunding-science**

2 Trending on Social Media: Handling and Storing Chemicals

As of August 15th, *Lab Manager*'s top July issue article posted to social media was our Health & Safety article on handling and storing chemicals. This article shares the basics of keeping yourself and your staff safe when dealing with laboratory chemicals, as well as the key regulations that must be complied with.

Read more at **LabManager.com/handling-chemicals**

3 Most Popular Webinar

Last month's top webinar on LabManager.com with 572 registrants was "Trash or Treasure: Optimizing Titration Electrodes and Consumables," presented by Jessica McVay, technical support specialist at Metrohm USA. This webinar shared how to troubleshoot a titration system and other important tips. Though it ran on July 27th, you can still catch it on demand at the link below.

Read more at **LabManager.com/optimizing-titration**

LabManager.com

NEXT ISSUE ➡ Funding Research

"If you really want to keep building innovative products, the government needs to keep investing in fundamental research," said Alan Bernstein, president of the Canadian Institute for Advanced Research. However, the Trump administration's proposed budget would reduce total research funding by almost 17 percent in 2018. The October issue will look at the impact such reductions could have on U.S. research institutions.

ASK LINDA

DEVELOPING A LAB SAFETY CULTURE

QUESTION:

Dear Linda,

Faculty at my university are charged with maintaining the safety of their individual research laboratories. But the time required to do so is limited because of teaching, research, and other responsibilities. As a result, instruments are often broken, misused, or incorrectly calibrated, and frustration builds up among students who do know how to observe proper safety procedures. This makes the likelihood of an incident or accident much greater. Any suggestions for helping faculty teach and enforce safety procedures in an efficient and cost-effective manner?

Hope you can help. Thanks,

Barbara

ANSWER:

Dear Barbara,

My first suggestion would be to incorporate safety procedures into the university course curriculum.

My second suggestion—which other academic institutions have implemented—would be to develop a safety inspection training program. Each month for about one hour, teams comprising both faculty and students would be given a checklist containing the same criteria used by 'real' inspectors to review the labs for safety compliance. As the teams perform the activity, both the professors and the students learn what the expectations of U.S. regulatory agencies are and then work together to improve the culture of safety.

My third suggestion would be to seek out an industry partner, from whom students could learn 'real world' laboratory safety practices. Such a program would ensure that future scientists and engineers have not only the scientific knowledge but also the safety knowledge to work efficiently and effectively.

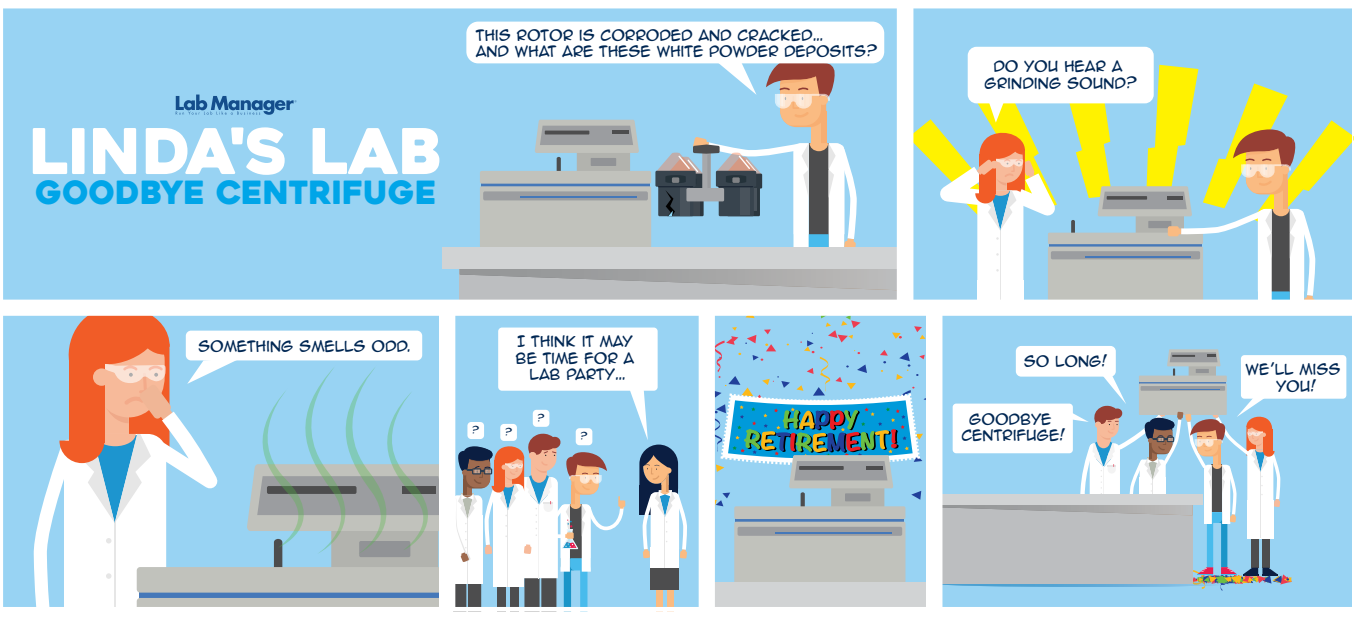
Hope this helps.

Cheers,

Linda

HAVE A QUESTION FOR LINDA?

EMAIL HER AT: *LINDA@labmanager.com*



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