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Today’s lab manager has a lot on his or her plate. First and foremost is the science—which, presumably is what got you where you are in the first place—but now your responsibilities have expanded to include evaluating and purchasing equipment, complying with regulations, managing human resources, controlling costs, developing laboratory safety programs, and so on. Add to that the speed with which technology advances and the need for managers to stay abreast, and it’s a pretty tall order. Fortunately, there are those who can help.

In this month’s cover story, Dr. Wendy Becker, professor of Management, Shippensburg University (Shippensburg, PA), says that a successful lab depends upon its “people assets.” “Keeping pace with changes in technology is a leadership challenge that centers on prioritizing employee training and professional development,” she says. These assets—the intellectual capital of one’s employees—are inimitable and should be highly valued. Turn to page 10 to learn more.

The importance of developing those same “people assets” is echoed in this month’s Leadership & Staffing article, “Nurturing Talent,” (page 32), which looks at a number of programs designed to develop tomorrow’s laboratory leaders. The article encourages managers to acknowledge and reward exceptional work done in their labs which, according to David Asai, senior director for science education at Howard Hughes Medical Institute (Chevy Chase, MD), can be done by encouraging the person to engage in more work on an important problem. “The greatest compliment is to be entrusted with carrying out an important job,” says Asai.

For managers charged with making outsourcing decisions, this month’s Business Management article offers some helpful advice for determining why, what, and when to outsource any part of your lab operation. According to Jerry Torrison, director of the Veterinary Diagnostic Lab at the University of Minnesota in St. Paul, “The most important thing is how critical it is that you have that service available at your own facility based on things such as turnaround time and cost.” Turn to page 24 for more outsourcing tips.

To learn about a lab whose challenges include snakes, killer bees, jungles, and floods, turn to this month’s Labs Less Ordinary article (page 16) to find out what goes on at the University of Akron’s Barton Lab, which specializes in cave ecosystem research. As is true for most scientific endeavors, Dr. Hazel Barton says that her cave research requires a willingness to “keep an open mind and modify [her] ideas quickly based on the evidence, rather than trying to make the evidence support [her] ideas.”

If you’re planning to be at Pittcon next month, check out our guides and previews (pages 60 and 70), and please stop by the Lab Manager booth #1955 to say hello.

Best,
Pam

Pamela Ahlberg
Editor-in-Chief
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Increasingly, both new and seasoned managers of labs of all sizes and disciplines are facing steep learning curves. In the quest to run their labs like businesses, managers are discovering that they need to be conversant with a host of new technologies such as artificial intelligence and laboratory automation (and workforce displacement), blockchain systems, green lab technologies, and a variety of fast-changing communication tools, among others.

It’s a given that accuracy, efficiency, and competitiveness rely on state-of-the-art instrumentation; accredited methods and procedures; and the optimal use of energy, water, reagents, and consumables. If these are not integrated and implemented effectively, however, the technical viability of the operation, as well as its legal, financial, and economic sustainability, could be undermined. As a result, lab leaders must have more than a passing familiarity with legal questions—complying with regulations, developing robust processes, registering and safeguarding intellectual property, when applicable—and a solid grasp of financial and budgetary questions that form the basis of cost controls; service (test) offerings, price-setting, and future investments in equipment, facilities, and the engagement of talented personnel.

On the subject of talent acquisition, Dr. Wendy Becker, Professor of Management, Shippensburg University (Shippensburg, PA), who specializes in Industrial/Organizational Psychology, says, “Keeping pace with changes in technology is a leadership challenge that centers on prioritizing employee training and professional development.” Her own work with laboratories centers around human resource management, employee selection and training, experiential learning, evaluation of training, and employee selection system design.

While squarely positioning human resource training and development as key aspects for labs seeking to stay ahead of rapid technological changes, Becker notes, “Different disciplines in the forensic sciences [my specialty] require different approaches to training personnel to keep abreast of technology change—and these approaches depend upon the relative degree of academic/experiential learning required to attain competency in the discipline. For example, forensic biology may require greater emphasis on academic knowledge, while questioned documents have historically centered on experience-based learning.

“Approaches to employee training can include professional conferences and seminars, apprenticeships, residencies, internships, instructor-led, and independent and distributed learning. Unfortunately, employee training and professional development are often the first line items to be cut or reduced from the lab budget. Managers must champion lab employees as assets to be protected in this regard.”
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On how to ensure that labs stay current with technology and relevant practices, Joe McGann, Regional Vice President, Accumen, Inc. (San Diego, CA), who has three decades of experience in the lab industry focusing on hospital and health system labs, says, “Aside from trade shows and association meetings—which are always a good source of information—visiting other labs to see their operations, processes, and related equipment can provide valuable insight.

“In addition, observing different ways to provide the same service is always educational. Most labs welcome their peers and are more than willing to share and even show off their pride and joy.”

Lab operations constantly seek effective ways to evaluate return on investment (ROI) when acquiring or building new facilities or units and when acquiring costly equipment. McGann says, “With the rapid changes in technology, there are numerous factors to consider when evaluating the potential acquisition of expensive equipment. With respect to the standard ROI calculation, it is important to ensure that the time horizon used is reasonable and that labs are not committing themselves to long-term contracts whereby they are unable to stay abreast of the technological changes because they have financially locked themselves into a long-term contract.”

Becker says that when the mix includes people, figuring out investment returns can be challenging. “While the value of calculating ROI is understood today, most organizations still find themselves struggling to move from operational reporting to analytics—especially with regard to understanding people as assets in the lab. For example, structured training programs are often more efficient than unstructured mentor training.

“The danger is that as mentors are often the most productive casework scientists, their time spent in unstructured training of new personnel can decrease the overall productivity of the lab. Time to competency is a measurable behavioral analytic in the lab. Intangible people assets are also important and undervalued—professional relationships between practitioner forensic scientist peers, students, academic faculty, and researchers.”

Lab managers today know that their businesses are expected—indeed, it’s an imperative—to deliver maximum value to their customers or other end users. McGann says, “The customers of laboratory services can vary. The three main customers of [clinical] labs include the provider, the patient, and the patient’s insurance company, and each of these customer’s needs are somewhat different. The provider and patient need timely, quality results. In the age of consumerism, the patient needs access and financial transparency. The insurance company needs data.

“In this era of value-based reimbursement, labs need to be able to provide all of the above, and at the same time be part of showing how they improved patient outcomes in ways that reduce health care costs.”

For forensics labs, Becker says that customer working groups (CWGs) can facilitate effective communication between labs and lab customers from the criminal justice community. “Representatives from law enforcement agencies, citizens, prosecutors, defense attorneys, and judges make up the CWG. Key steps include the CWG working together to develop a mission statement, policy, procedures, and regular communication and outreach activities.”

To establish and maintain a business-like posture that is distinct from their peers, lab leaders constantly seek ways to differentiate themselves and highlight their strengths. McGann says that to emphasize their value proposition,
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labs need to collectively and consistently implement and sustain four main factors to differentiate themselves and flourish:

“Ensure the trains run on time all the time—in other words, consistent reliable service.

“Service needs to be coupled with quality that must be shared with all customers.

“The service and quality need to be provided at a competitive rate. Therefore, since the revenue factor is, for the most part, fixed and established by the payers, a lab’s cost base of operations needs to be lean, cost efficient, and effective.

“And last, labs need to be able to provide data in a format that is needed by the insurers’ beneficiaries.”

“From the private sector, the concept of employee selection and training as an important aspect of an organization’s brand may help labs differentiate themselves,” says Becker. “What I mean is that labs can distinguish themselves by hiring and training effectively. People assets—the intellectual capital of the employees who are selected and retained—are inimitable, meaning they can’t be copied or reproduced.

“For example, lab managers can use performance management strategies to help employees develop their technical expertise—and that will help retain key personnel. Labs can develop innovative approaches to design and deliver new technology, such as mobile and virtual training, simulations, online courses, and social-learning tools, such as wikis and communities of practice. The intellectual capital of the lab, unlike equipment or a new procedure or facility, cannot be reproduced.”

Turning to the crucial questions of effective budget management and revenue and earnings growth, McGann says, “In order to be competitive and/or stay competitive, lab managers need to run their labs like a business and therefore the need for timely financial information is crucial—and just as important is the need for the information to be acted upon.

“Lab managers need to ensure that they are getting all the data in order to properly manage their budget. Examples include volumes by payer, reimbursement by payer, productivity in both the pre-analytical and analytical departments of the lab, and client profitability, among others. This information will shine the light on where to focus the budgetary efforts; alternatively, without this level of information, especially in larger labs, if there are budgetary problems, the lab manager will not efficiently know where the efforts need to be focused.”

“The fiscal environment in public service agencies relies upon external policy realities and the state of the economy, with fiscal constraints ever-present. Public agencies must be the best stewards of the taxpayer dollar, providing the best forensic services in a timely and quality manner,” says Becker.

“Labs can be considered as business entrepreneurial ventures with business plans. Lab managers can receive professional development in fiscal management; for example, a master’s in business administration or a certificate program. Managing requires measuring key performance indicators so that managers can move from a reactive posture to proactive management of the lab,” adds Becker.
On how labs should go about setting up and analyzing these performance metrics, McGann says, “Similar to managing a budget effectively, access to key and timely performance metrics is critical. As I noted earlier, part of the value proposition of a successful lab includes consistent service and quality metrics. However, labs should not try to measure every service and quality metric or the dashboard can become diluted. Collaboration with the physician customers to determine what is important to them is fundamental. Once the few key metrics are established, the lab can concentrate on ensuring the consistent delivery.

“Just as important is communication of the results with not only the entire lab, but the physician customer as well. The physician needs to know that you are measuring and analyzing the agreed-upon metrics, and acting upon them accordingly if need be.”

Becker notes that, “In our book, Forensic Laboratory Management: Applying Business Principles, Mark Dale and I discuss seven key areas to develop in a lab management performance model. These are: law enforcement requirements, costs, capabilities, cost-benefit metrics, performance, benchmarking, and return on investment.

“As one example, benchmarking involves identifying the key metrics that can be compared with other similar-sized labs serving similar law enforcement agencies in scope and geopolitical service area. Benchmarking allows laboratories statistical comparisons of data that can serve as a management tool for laboratory managers. Individual labs can request peer lab contacts with best practice agencies for facilitating discussion.

“Benchmarking requires forming trust relationships between partners and sharing confidential data, while keeping metrics useful and easy to monitor. Many labs willingly share their best practices for the greater good,” Becker concludes.

Bernard Tulsi is a freelance writer based in Newark, Delaware. He may be contacted by email at btulsi@comcast.net or by phone at 302-266-6420.
When asked to imagine a research lab, a brightly lit space filled with beakers and microscopes set on top of workbenches, and modular analytical equipment and safety procedure signs lining the walls likely comes to mind. But for Dr. Hazel Barton and her team at the University of Akron, the scene is much different—it’s typically dark and dirty, and usually difficult to access.

The Barton Lab at the University of Akron specializes in cave ecosystem research, and uses interdisciplinary tools to answer questions at the interface of biology, chemistry, and geology. Examples of these questions include how microbes live in extremely nutrient-limited cave environments and how to discover novel antibiotics in new environments. The team has also carried out research related to cave formation and fungal systematics. “The goal of our lab is to understand what the limits are for life on Earth,” said Dr. Barton, a cave microbiologist as well as a professor and director of the Integrated Bioscience Program at the University of Akron. Barton has been an avid caver for about 30 years, having explored caves on five continents. Her explorations have been featured in Forbes, National Geographic, and Smithsonian Magazine, as well as on NPR, BBC Radio, Animal Planet, and other major outlets.

The Barton Lab team is currently made up of 17 people, including postdoctoral fellows, PhD students, MS students, and undergraduates. While Barton and her students do have a “home base” with a more traditional lab at the University of Akron, they frequently spend days or weeks at a time navigating to sample sites deep underground. The team has traveled to sample sites all over the United States and the world, with some located more than 1,000 feet underground and many miles away from the initial entrance point. “We’ve been lucky in that some of our sample sites are in some of the most beautiful caves on Earth,” said Barton. As she explained, reaching these sites requires a combination of endurance and technical climbing while also making sure to not ruin any of the analytical equipment during the climb to get to the site. But the emotional and physical challenges of caving are what initially piqued Barton’s interest in the activity when she was just 14-years-old. She has made a career out of exploring and discovering things that may have otherwise never been found.
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What can we learn from caves?

As Barton explained to Lab Manager, cave environments are separated from surface processes, which are mostly driven by photosynthesis, which in turn puts a lot of energy in the system in the form of organic carbon. But Barton’s team is interested in environments isolated from that organic carbon, requiring her and her researchers to go deep underground and far away from surface input. “In some of the caves we study, it can take 10,000 years for energy to get to the sample site from the surface,” she said. “What we find there are microbial communities that have developed processes that allow survival in these conditions, from obtaining energy directly from the rock to high levels of chemical competition by antibiotic production and antibiotic resistance.”

The Barton Lab always has numerous projects going on at once, all with specific goals and topics of focus.

The research is funded by the National Science Foundation, the US Fish and Wildlife Service, and the National Park Service. One exciting project currently underway focuses on cave formation in Brazil. An ancient type of rock known as banded iron formation (BIF) first formed throughout the country during the Great Oxidation event 2.2 billion years ago. It is intriguing because it is rich in iron and resistant to weathering and dissolution, yet there are thousands of caves found carved in BIF. Therefore, Barton and her team are studying how microbes may be driving the dissolution processes to form these caves.

But reaching these sites, which are often in very remote areas inaccessible to tourists, can be an expedition all on its own. “Getting to the caves is pretty exciting—there are snakes and killer bees and jungles and floods. It’s like an Indiana Jones movie working there,” said Barton. Once the researchers reach the entrance to the cave, they need
1. PhD student Katey Bender examines a collected sample in Lechuguilla Cave, New Mexico. This sampling trip required spending four days underground up to 1,500 feet below the surface, involving 22 different rope climbs.  

2. The Barton Lab Team: (front row, from left) David Lowry (technician), Katey Bender (PhD student), Maria Dhinojwala (high school student), Sarah Twitchell (MS student), Olivia Hershey (PhD student), Joe Kainrad (undergraduate student); (center row, from left) Hazel Barton (PI), Kayla Capala (MS student); (back row, from left) Katelyn Glover (undergraduate student), Ashwin Ghatpande (undergraduate student), Ceth Parker (PhD student), Matt Jennings (Post-doc), Charbel Cherfan (MS student).  

3. Undergraduate student Andrew Wallace, 660 feet underground and several miles from the entrance in Wind Cave, Wind Cave National Park, South Dakota. Wallace is looking at the surface of the Madison Aquifer, which is one of the most important drinking water sources in the US.  

4. Katey Bender analyzes the microbial community within an isolated lake 1,200 feet underground.

Credit for all photos: Dr. Hazel A. Barton

to carefully hand-carry all their tools, food, and sleeping supplies to the sample site. “These sites are so isolated that we’re often the first humans to ever see them,” said Barton, “and there’s not even enough energy to support protozoan life. It’s really, really isolated.” Sterility is perhaps the biggest challenge for the team. Working in muddy, dark, tight quarters underground is certainly not ideal when trying to re-create a lab environment in a cave. Everything that enters the cave is gamma-irradiated and wrapped in a protective covering to stay sterile. The team also brings plenty of extra tools and gear—as much as two to three times what it needs—to avoid sterility issues and replace anything that may get damaged on the journey to the site. Additionally, all equipment must be compact, lightweight, and battery-powered. The equipment often needs to fit through passages that are less than 20 cm in height. The researchers also have what Dr. Barton calls a “magic box”—on every trip, each student is required to add something to the box that may come in handy, like scissors, tape, needles, zip ties, or sterile aluminum foil.

The type of equipment needed on the expeditions can vary depending on the project. Sometimes pumps are required, while other times simple hammers and chisels are needed to collect microbes from rock. Often a Dremel tool is the most useful device. In the field, the team will record geophysical measurements, like pH, temperature, and humidity, and then review the data back in the lab using a combination of genetic, geologic, and materials chemistry techniques. Back at the University of Akron, Barton and her team work with a variety of materials and analytical chemists to carry out chemical identification and other techniques critical to their projects. For every week the researchers spend out in the field, they’ll spend about a year completing their research in the university lab, according to Barton.

The work often produces unexpected results, and can raise new questions—something that Barton describes as both a challenge and an exciting aspect. “The microbes never seem to behave the way we imagine, so a lot of time we think we know what we’re looking at, and it turns out to be completely unexpected. Being willing to keep an open mind and modify our ideas quickly based on the evidence, rather than trying to make the evidence support our ideas, is always a challenge, but it keeps us on our toes,” said Barton.

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January/February 2019 Lab Manager 19
“New needs need new techniques. And the modern artists have found new ways and new means of making their statements...”

Jackson Pollock
SPECTROSCOPY REDEFINES THE SCIENCE OF ART AUTHENTICATION

Historically, when attempting to authenticate a particular work of art, or when attributing a painting to a particular artist, the task has fallen to the curator and the art historian.

The curator’s role is to examine the provenance of a particular piece by determining the succession of ownership back to the original artist, while the art historian typically would perform a stylistic analysis to determine if the piece reflects the artist’s particular technique and application as well as their style and brushwork. Unfortunately, in many cases the provenance of an artwork is simply not known, or can’t be reliably validated, and a skilled and clever forger can often imitate an artist’s particular style and technique, making the entire evaluation somewhat subjective.

Nowadays, when attempting to attribute a piece of art to a particular artist you are more likely to encounter scientists working behind the scenes at a gallery or museum. New techniques and advances in a number of analytical instruments allows the body of a painting to be examined in spectacular detail to determine the precise composition of organic and inorganic pigments and binders. Specifically, X-ray fluorescence spectroscopy (XRF), infrared spectroscopy (IR), and Raman spectroscopy offer simple, non-destructive, in situ analysis of paints, pigments, and resins. Spectroscopic analysis of a questioned artwork can provide critical information regarding the materials and chemical composition of pigments used—either supporting its authenticity or revealing materials inconsistent with the item being genuine.

CASE STUDY: TWO RECENTLY DISCOVERED POLLOCK PAINTINGS

Roughly 2 ½ hours from Bucks County, and 3 ½ hours outside of New York City lies Mill Hall Pennsylvania, the location of the Lock Haven Motel—the original home of two purported Jackson Pollock paintings, known as Mill Hall #1 and Mill Hall #2. According to local lore, Pollock gifted the two paintings as payment for a hotel/bar visit while traveling through the town. Given Pollock’s lifelong struggle with alcoholism, this may be a plausible scenario and consistent with other Pollock paintings made by the artist for barter. Regardless, it is known that Jackson Pollock was included in an exhibit in Lock Haven, PA in 1951 where his sculpture was being exhibited as part of the Museum of Art tour, which supports his connection to the community.

In 1992, Mill Hall #1 was examined by the Philadelphia Museum of Art. However, with incomplete provenance, no analytical testing or side-by-side comparison was completed. In 2003 both pieces were rejected by the International Foundation for Art Research (IFAR) for incomplete provenance and artistic interpretation.

However, recent analysis of Mill Hall #1 and #2 performed by Tom Tague, PhD of Bruker Corporation (Billerica, MA) provides compelling evidence that these paintings are in fact genuine Pollock originals.
ANALYSIS OF MILL HALL #1

Mill Hall #1 (Figure 1), is typical of Pollock’s abstract expressionist “drip painting” style with a limited color palette characteristic of many of his other works. The work itself is on masonite and has been cut down slightly for framing. In an attempt to authenticate the two paintings, they were analyzed by Tague using Bruker Technologies XRF, IR, and Raman spectroscopy instruments.

Analysis of the black drip paint indicates an alkyd enamel paint containing both lead- and carbon-based pigments. This is consistent with paints used at the time Pollock was painting. Raman spectra of the black and gray areas identify the pigment as Bone black based on reference pigment.

Red drip IR analysis indicates an alkyd enamel paint containing calcium (calcite) and is a library match for PR3. Further, the Raman spectrum of the red drip is an almost perfect match to PR3—an azo-naphthol pigment known as Toluidine red used by Pollock in at least two other known paintings.

Analysis of the white and blue drips by IR also both indicate an ortho alkyd enamel, while Raman spectrum is a match for titanium dioxide rutile anhydrite and Prussian blue respectively.
The Raman spectrum of the yellow drip identifies it as chrome yellow; additional bands at 448 and 609 nm also indicate the presence of TiO$_2$ rutile anhydrite. XRF indicated the presence of both lead and chromium, while IR indicated an ortho alkyd enamel consistent with the other drip colors.

Finally, the Raman spectrum of the green drip indicates it was comprised of both the Prussian blue and a smaller amount of the chrome yellow (Figure 2). As with the other colors, the paint was identified by IR as an ortho alkyd enamel, and XRF indicated the presence of both lead and chromium.

**ANALYSIS OF MILL HALL #2**

Mall Hall 2 (Figure 3) bears striking similarity to other Pollock works of the same period both in style and color palette. Spectroscopic analysis of the pigments showed exact matches to Mill Hall #1 for bone black and toluidine red, while the Raman gray spectra was a combination of the previously collected black and white spectra.

Perhaps the most interesting result from the analysis was the discovery of an obscured signature across the body of the painting in Pollock’s typical style (Figure 4). This is a significant finding as this has not been previously noted this obvious in any of Pollock’s other works. The work “Mural” also is suspected of containing Pollock’s name within the painting. Further analysis conducted separately notes that the letter style is similar to typical Pollock signatures, particularly the distinctive “J” partially visible on Mill Hall #2. Separately, the actual signature in the lower right portion of the painting contains a black paint droplet on top of the signature. This was verified by FPA FTIR imaging, confirming that the Pollock signature at the bottom of the painting was in fact a signed work.

Overall, spectroscopic methods are an effective tool for conducting a detailed study of elemental and molecular composition. In this case, elemental, IR and Raman comparisons of the Mill Hall paintings to other known Pollock works show that they are very similar in nature, and that the paint types were consistent with those used at the time by Pollock. In fact, no inconsistencies in paints identified were found when compared to previously known Pollock works.

This evidence, when combined with other scientific testing including carbon dating, fingerprint analysis as well as mitochondrial DNA analysis, and with recently updated provenance, suggests that two new pieces may be soon added to the works of the artist many consider to be the greatest painter America has ever produced.

This feature was crafted by Lab Manager’s Creative Services Team and sponsored by Bruker.
Likewise any other business, laboratories and the organizations they are affiliated with continually struggle with cycling budgets, staff, and capabilities. As such, a decision that lab directors and managers must periodically make is determining what portion of the lab’s tasks and support functions to keep in-house and what portion of the work to outsource.

The answer is not always simple. Not only do internal considerations account for the decision, but also the potential and existing clientele, though indirectly, are a factor. “People expect you to provide a full slate of services, and if there’s something missing from your catalog, they might think that you’re not the one-stop shop that they’re looking for, and so you have to be careful in determining what you think is vital for your core clientele versus what you can afford to outsource,” says Jerry Torrison, director of the Veterinary Diagnostic Lab at the University of Minnesota in St. Paul.

Torrison’s lab, accredited by the American Association of Veterinary Laboratory Diagnosticians (AAVLD), is heavily involved with testing livestock and poultry for infectious diseases. Although the lab provides a broad set of tests for, and works with, wildlife and traditional pets like cats and dogs, the bulk of the lab’s analyses involve PCR testing, virology, and bacteriology, essentially looking for infectious diseases or evidence of prior infection antibodies in livestock. Each year, his lab runs approximately 55,000 cases and conducts 124 million procedures.

In the numbers

In order to decide which of the millions of procedures to keep in-house and which ones to outsource, Torrison has to periodically consider several factors, including the status of the lab. Sometimes a change is brought on by, for example, a faculty member or a key technicain retiring or the need to upgrade equipment because there’s been a change in that particular field that might require a massive investment.

“The most important thing is how critical it is that you have that service available at your own facility based on things such as turnaround time and cost,” Torrison says. “So cost is certainly a big driver of it. Can you find it somewhere else at an acceptable cost and level of service? Then, that’s rolled up against the cost to upgrade or initiate that service and the numbers usually figure themselves out.”

The volume of work is a big determinant of those numbers. In many cases, when a lab offers a service at a low-volume, high-specialty rate, it makes sense to outsource the related procedures and tests. That’s because it’s hard to justify maintaining equipment and full-time employment for a procedure that’s only performed every so often. Furthermore, tests will likely produce more accurate results when a person is repeatedly performing them.

“Torrison and his team ensure that anyone they send samples to meets the same strict standards as their own lab.”
For example, “If you took something like Lasik surgery, you want to go to someone who does it often, not someone who does it once in a blue moon,” says Miguel Ilzarbe, director for operations and research administrator at The Jackson Laboratory for Genomic Medicine in Farmington, Connecticut.

“So, typically in lab services, as a strategy for an organization, you outsource it when it’s low volume for your organization. Then, as there’s more demand on the inside, that’s when you kind of want to refresh and look and say, ‘Okay let’s do a cost-benefit analysis. Can we cover enough of a full-time employee plus equipment and whatever else to do that test or that service?’” Ilzarbe says.

Although The Jackson Labs as a whole is well-known for making mice, at The Jackson Laboratory for Genomic Medicine, where Ilzarbe runs the operations, the focus is on the treatment and understanding of common diseases—which means that branch of the organization focuses on what is found in the mouse model system and tries to translate the results for humans. The genomics lab is well equipped, so his team is capable of conducting most of the work for studies that they need conducted in-house. However, Ilzarbe’s lab still outsources some of the clinical tests, such as those in oncology—like cancer panels, where specific mutations of individuals are looked at. As their circumstances continue to change, however, they are now considering offering that service in-house. “This department is getting the ability, people, and the expertise to do it,” says Ilzarbe.

In addition to bench tasks, lab managers need to consider either keeping or outsourcing support function tasks, such as cafeteria management and grounds- and housekeeping. Many opt to outsource these, as it allows the lab staff to focus more on scientific endeavors.

The Veterinary Diagnostic Lab, for example, has two facilities, one in its main university campus and one outpost in and of itself. At the main campus facility, the lab has very much been supported by the essential university services. Therefore, maintenance and power and such have almost been entirely managed through the university.
“That’s changing somewhat, so we’re having more outsourcing of that—for example, equipment monitoring and some of those things we’re finding the university’s stepping away from,” Torrison says. “So we need to find our own vendors for those tasks. For the outpost facility, much of grounds-keeping, building maintenance, and the like is outsourced to private and commercial vendors.”

“All who consider outsourcing services should also factor in turnaround time.”

In addition to outsourcing support function tasks, the Veterinary Diagnostic Lab also sends out toxicology tests. “We no longer maintain a toxicology service because not every lab can do it, and some decided to keep it and others not,” Torrison says.

Finding outsourcing partners

To ensure that the outsourcing partner is reliable and meets the standards of their own work, Torrison and his team ensure that anyone they send samples to meets the same strict standards as their own lab. “We look at the availability of an alternative provider that we trust, so we rely on other AAVLD-accredited laboratories to provide services,” he says.

Another approach to ensure quality of tests that come from outsource partners is to look at their results. For this, Ilzarbe typically relies on reference samples.

“[you] could every so often send a known sample out to whatever service you’re using just to see what quality sample data you receive back.”

All who consider outsourcing services should also factor in turnaround time—will the subcontracted lab or vendor meet your standards when it comes to deadlines?

“If you were to outsource it to a for-profit company, which does that [task] all the time, turnaround time will be less, and quality could be the same or better, but then you [could] have customer service issues, right?” Ilzarbe says. “Also, you become a client as opposed to a collaborator.”

Organization mission

Despite the downside of becoming a customer to a vendor and losing some control over the work, outsourcing can take some load off of an organization and free up time or resources for the lab to perform other services, essentially making tasks that require a partner more sustainable.

An example of this is tests related to toxicology for the Veterinary Diagnostic Lab at the University of Minnesota. “We don’t just use a single provider at the toxicology services because even that has a broad spectrum of services that can be needed. So we primarily use one lab. And there are other tests that are available at different labs that, on occasion, are needed for specific cases,” Torrison says.
“So even if we had our own toxicology lab, we would still need to be sending some things out because no one place can do everything,” he says. “It’s really more about having a broader set of options.”

Furthermore, these decisions are not static and tend to change as technology, capabilities, and tools advance. For example, some years back, DNA sequencing was a highly specialized task that was performed by elite scientists such as Nobel laureates. Now, with the correct tools, high school students can perform such tests.

“You can do some of those tests just because over time people have perfected the steps and the methodology, and it’s just been reproduced so many times,” Ilzarbe says. “So some of the reasons we bring this stuff in-house are because volume increases and technical difficulty decreases.”

In the end, the decision to outsource or insource tasks has to align with the mission or the priorities of the organization. So if the priority is to allow researchers access to a service or results of a test at the drop of a hat, then that could persuade managers to keep the related tasks in-house.

“If you’re okay potentially going into a queue of an outside service provider, and if turnaround time isn’t the most important thing for the organization, then it’s okay to outsource,” Ilzarbe says. “So besides tactical things of cost and turnaround time, I think there’s a strategic view of whether to outsource or insource based on [the overall] organization mission or organization strategy.”

The key is to understand that the idea and capability of outsourcing can only work to enhance an organization and the related laboratory services.

“Each lab is unique and has to understand its customer base and development strategy in order to deliver the best service tailored to that customer base,” Torrison says. “And because of the cost of equipment and the degree of training required in specialized areas, outsourcing continues to be an important part of providing a complete set of services.”

Sara Goudarzi is a freelance writer based in New York City. Her website is www.saragoudarzi.com.
The availability of helium has become a major issue for scientists. Helium is a non-renewable resource produced through radioactive decay. Because of its non-renewable status, the supply is unable to keep up with the increasing demand. As a result, the price of helium continues to rise, while its availability becomes increasingly unpredictable. The future of helium is uncertain and it’s time for scientists to start considering alternatives. With industry leaders like Parker Hannifin paving the way, hydrogen gas generation is a more accessible option than ever before.

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THE SHORTCOMINGS OF HYDROGEN CYLINDERS

Many of the safety concerns about using hydrogen gas originate from the use of gas cylinders to store the hydrogen. These cylinders contain large quantities of flammable gas under high pressure and pose risks to the personnel handling and transporting them. They are also inconvenient, as they have to be changed frequently and monitored regularly. Additionally, the GC instrument must be shut down while tanks are changed, adding to the instrument's down time.

There are also concerns about purity when using hydrogen cylinders. Contamination can vary from cylinder to cylinder. These small variations can have a big impact on sensitive assays. Contamination can also be derived from the tubing, joints, and elbow seals connecting the cylinder to the GC instrument. Cylinders are typically stored a distance from the instrument, increasing the amount of tubing needed as well as the opportunity for contamination.

Finally, and most importantly, the cost of hydrogen cylinders can be great. Not only are you paying for the cylinder and the gas within, but also for delivery charges, gas management controls, safety equipment, installation, and maintenance. All of these costs add up and take a bite out of your lab’s operating budget.

BENEFITS OF HYDROGEN GENERATORS

A solution to the shortcomings of hydrogen cylinders is to replace them with a hydrogen generator. This technology allows for the on-demand production of ultra-pure hydrogen. Using a hydrogen generator eliminates the need to change cylinders or monitor gas levels. It’s also a safer option as gas is generated as it’s needed, meaning there are no stores of flammable hydrogen gas in your lab. As well, personnel do not have to handle heavy tanks full of compressed gas.

Gas generators also come with safety controls that regulate and monitor features such as pressure, flow, purity, gas volume produced, and run time hours. The Parker PEMPD Series Ultra-Pure Hydrogen Generator has several safety controls and is able to notify the operator when the system requires service using visual and audio alarms.

Gas generators can also help overcome issues with contamination. Not having to change the cylinders decreases the risk that the system will be exposed to contamination when the tank is disconnected. In addition, the small footprint of gas generators allows you to store them right beside your instruments, decreasing the amount of tubing between the hydrogen source and the instrument and reducing the risk of contamination during gas transport.

Purchasing a gas generator means eliminating the cost of renting a cylinder, the gas within the cylinder, delivery, accessories, safety equipment, installation, and maintenance. More importantly, you will have implemented a reliable solution that will give you peace of mind when performing experiments in the years to come.

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Hydrogen vs. Helium for GC

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Here are countless programs and initiatives geared toward encouraging young students to pursue a degree in STEM fields. But what happens when those eager individuals enter the workforce? How can managers continue to foster talented individuals throughout their careers and ensure they are getting the most out of their team members?

In order to train the next generation of laboratory leaders, you need to be an effective leader yourself. Set a good example for your staff by acknowledging and rewarding exceptional work, consistently utilizing good listening skills, and allowing your passion to be contagious.

“Developing leaders here is a strong suit of the lab,” says Dr. Paul Kearns, who has nearly 30 years of management experience and is currently the director of the U.S. Department of Energy’s Argonne National Laboratory. “What I try to work on as a leader is developing opportunities for others and helping them realize their talents and put them to good use.”

Early development

National facilities like Argonne, which attracts thousands of students and hundreds of postdocs each year to participate in outreach and educational programs, provide the top-notch, real-world experiences that young, talented individuals strive for to help jump-start their careers. “We work on developing skills with [the students], and get them thinking about what they want to do with their careers,” says Kearns.

Sandia National Laboratories takes a similar approach to leadership development. A new fellowship program called the Jill Hruby Fellowship will immerse postdoctoral candidates in a three-year technical leadership development program at Sandia. Not only will the fellows get to carry out high-level research projects and advance their technical skills in the lab, but they will also receive valuable guidance from an executive mentor. Susan Seestrom, chief research officer and associate laboratories director for advanced science and technology at Sandia, will be mentoring the first two fellows—Mercedes Taylor, who earned her doctorate in chemistry from the University of California, Berkeley, and Chen Wang, who completed her doctorate in materials science at the University of California, Irvine. “Sometimes, having a senior person committed to one’s success can make all the difference in the ultimate level achieved. I would love to make that difference in the careers of these two amazing women,” says Seestrom.

The Jill Hruby Fellowship allows the chosen honorees to challenge themselves and see exactly what they are capable of when given the resources to succeed, which is what nurturing talent is all about. “This is an excellent fellowship and a great opportunity to do your own projects—propose your own research and design and execute
it yourself—all within a world-class organization,” says Taylor. She will be researching water desalination and purification while at Sandia in hopes of making materials that will improve these processes.

The Gilliam Fellowships for Advanced Study at the Howard Hughes Medical Institute is another example of how to establish leaders and foster talent early on. In July 2018, 45 doctoral student-adviser pairs from across the country were each awarded a $50,000 grant to support the development of their scientific leadership and commitment to advance diversity and inclusion in the sciences. As part of the fellowship, the students’ thesis advisers will participate in a year of mentor development activities, including online training and two in-person workshops.

“The mentor training activity is an important and unique benefit of the award. It is a way to leverage the award to improve the training environment in a sustainable and amplifying way,” says David Asai, senior director for science education at Howard Hughes. Both Kearns and Asai express the importance of mentorship throughout one’s career, and note that they both still refer to a handful of mentors when they need someone to bounce ideas off or get advice. “I continue to benefit from dozens of persons who each, in their own way, taught or teach me something about being a scientist, or a teacher, or a leader,” adds Asai.

Creating an enriching work environment

Fellowships and similar opportunities can create a great foundation for talented individuals just starting out in their careers, but seasoned individuals with years of experience can also benefit from proper acknowledgement of their work and chances to showcase their talents in new and meaningful ways.
To do this, managers should provide ample opportunities for their team members to excel not only in the designated role they were hired for, but also within other aspects of the organization. Individuals who exhibit leadership skills or a curiosity to train in different branches of the facility are an asset, and allowing them to learn new roles will set them up for future success within the organization.

Another effective method to managing talent is for lab managers to instruct their staff to develop annual personal development goals. Outlining and discussing these plans can keep team members motivated and encourage professional growth.

“It’s important to be intentional...certainly distractions or setbacks may come up along the way or the course of action may not go as planned, but being intentional about making good progress toward a goal is really essential,” says Kearns.

Providing a safe, welcoming environment is another key to fostering talent in the workplace. “I prefer to think about excellence as the culture of an organization. An excellent organization provides an environment in which creativity can emerge; in the case of science excellence, the creative ideas are applied to hard scientific problems,” says Asai.

And as Kearns explains, “How you do it is as important as what you do.” To emphasize this point, Argonne staff recently established a set of five core values: impact, safety, respect, integrity, and teamwork. Working with a similar set of values in mind will ensure your team is producing meaningful results.

One of the best ways to elevate your staff’s engagement, commitment, and skill sets is to acknowledge and reward exceptional work. Because who doesn’t like feeling valued and appreciated?

Managers can recognize an individual’s success by rewarding them with more than just monetary compensation. For example, giving them the chance to speak at conferences, highlighting their efforts at meetings, or providing them with a leadership role over a project of their choice will be all-around beneficial.

When asked about the best ways to reward excellent work within the lab, Asai says, “Give them more. Encourage the person to engage in more work on an important problem. The greatest compliment is to be entrusted with carrying out an important job. That means you are trusted and valued.”
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At 3:31 p.m. on January 15, 2009, US Airways Flight 1549 landed—in the Hudson River. Following a bird strike 95 seconds after takeoff that disabled both engines of the 50-ton A320 Airbus, options became severely limited. Understandably, this was a heart-stopping experience for the 155 aboard, all of whom survived the ordeal. This incident soon became known as the “miracle on the Hudson.” But upon some consideration, was it really a miracle? Or was it, perhaps, something less remarkable? Might success be better attributed to the effective leadership and communication skills demonstrated on that day by the now-famous pilot, Captain Chesley “Sully” Sullenberger, and First Officer Jeffrey Skiles?

Consider how Sullenberger later described the situation: “… during this dire emergency—with no time to verbalize every action and discuss our situation—we communicated extraordinarily well. Thanks to our training and our immediate observations in the moment of crisis, each of us understood the situation, knew what needed to be done, and had already begun doing our parts in an urgent yet cooperative fashion.” (Sully, pp. 310–311.)

Captain Sullenberger’s words can rightly motivate leaders in any field of oversight; they explain why laboratories today need to prioritize the development of strong communication skills. What characterizes strong leader communications? Effective leaders (1) actively seek to involve those around them, (2) use communications tools effectively, and (3) precisely adjust their messaging to fit the audience.

How does a leader in the laboratory do this? What is it about effective communication between leaders and those around them that brings success? What might we learn from the success of Flight 1549?

1. Active systemic communications, both formal and informal, build strong team bonds

Captain Sullenberger and First Officer Jeffrey Skiles had never met prior to their seven-leg flight assignment that January, so the captain made it his priority to get to know his first officer. Over the three days and six flights preceding Flight 1549, he had several casual, informal conversations with Skiles. Additionally, before each flight, the two formally reviewed safety procedures and ran through all pre-flight checklists. When they experienced the bird strike just seconds after Flight 1549 took off, they determined that both engines had shut down. Captain Sullenberger took immediate control of the flight and concentrated on his responsibility to make a successful emergency landing. First Officer Skiles focused on his task of working the checklist for restarting the disabled engines. For the next three terrifying minutes, each man worked on separate tasks, but they worked as a team, communicating and cooperating in a way that allowed them to make dozens of smart, lifesaving decisions.

Applying this experience to the laboratory setting presents questions. Have we “informally” come to know our team members as individuals through casual conversations? Are
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our “formal” communications clear and unambiguous? Do we give direction that both leader and team understand? Are all team members informed and involved? Consider, for example, the staff meeting—a necessary part of most organizations today. Do our staff meetings allow for informal communications before and after the meeting, as well as formal communications that focus on plans, reports, and other necessary business? Do we communicate an agenda in advance and follow up with meeting minutes and deliverables? One measure of the effectiveness of our communications is the efficiency of our staff meetings; meetings that do not waste time, that involve the entire team, and that build strong bonds among team members are a reflection of strong leadership.

2. Communication tools, like checklists, standardize important tasks

During the Flight 1549 emergency, all aircraft staff followed well-documented procedures. Captain Sullenberger flipped to the “ditching” checklist. First Officer Skiles implemented the “dual engine failure” and the “engine restart” checklists. Cabin crew members carried out their emergency duties and followed their checklists as well. Similarly, in the laboratory, well-documented procedures standardize tasks and remove ambiguity. These can help a team stay on track, prevent them from overlooking key steps in important processes, and consistently keep all staff members informed of duties and expectations. Do we have processes and procedures in place that specify how performance is measured, how and when bad news is communicated, or what is expected of staff in the event of specific emergencies? Clearly stated and easily located checklists that are thoughtfully developed and precisely written before a crisis occurs can spell the difference between success and failure in managing that crisis.

3. In high-energy situations, precise messaging promotes action

Things are understandably tense during a major aircraft malfunction; losing both engines when climbing out of a metropolitan area calls for rapid, clear communication with several different “audiences.” Sullenberger communicated back and forth with the New York Air Traffic Control Center to locate and eliminate possible landing options (“You can land on Runway 1 Teterboro”—“We can’t do it”), with First Officer Skiles for engine restart attempts and landing alignment (“Got any ideas?”), with the cabin crew to prepare to ditch (“This is the captain: brace for impact”). Even after landing, he talked with frightened passengers, personally walking through the entire airplane and assuring them that it was both safe and essential to evacuate quickly. Each of Sullenberger’s communications was clear and precise and took into account with whom he was interacting at the time. Is our communication with all levels of our organization—from C-suite executives to HR to new employees—easily and clearly understood? Does our leadership training include how messaging can have the most effective impact when our audience varies?
With extroverts and introverts, for instance, communications may require subtle, but precise, adjustments; with an extrovert, a simple “Please get this done, today” may be welcomed for its clarity, whereas an introvert may respond to a less direct approach.

Following the successful landing of US Airways Flight 1549, Captain Sullenberger made an important observation: “With authority comes great responsibility. A captain needs leadership skills to take the individuals on his crew and make them feel and perform like a team.” (Sully, p. 192.) By learning to look for and use opportunities to build confidence and rapport among team members, by developing and implementing clearly stated procedures and standardized checklists, and by tailoring communication approaches to fit the audience, we can successfully equip the individuals on our “crew” to feel and perform like a team.

Leaders in the laboratory setting who accept the responsibility to train and develop effective communication skills will no doubt see impressive, perhaps even miraculous, results.

Rick Parmely is the founder of Polished and Professional LLC, a training company that specializes in improving personal and professional communications resulting in enhanced leadership skills. He can be reached at rick@polishednprofessional.com.

References:

Register now to join Rick Parmely at this year’s Lab Manager Leadership Summit (May 13-15, 2019 in Raleigh, NC), where he’ll be hosting an interactive event addressing effective communication as a key leadership skill.

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Purchasing used equipment can be a great cost saver for labs that are strapped for cash. However, as with new equipment, it is important that sellers of used equipment stand behind their products. “Simply put, customers are looking for some kind of assurance that the system will work and that the seller provides support for the product in the event of a malfunction,” says Rich Tula, lead product specialist at Biodirect (Taunton, MA).

A variety of options for warranties are available, depending on which vendor you buy from. For example, GenTech Scientific (Arcade, NY) offers one-year warranties on its equipment as well as extended two-year warranties, says CEO Clair Bragg. International Equipment Trading Ltd. (Mundelein, IL) also offers a standard one-year warranty on its equipment, but customers may request a shorter warranty for a lower price, according to Ceylan Bilgin, VP of marketing. Additionally, Biodirect offers a full original equipment manufacturer (OEM) warranty, says Tula.

Whether a warranty is required depends on the type of equipment you’re purchasing and who you ask. “For something like a higher-end instrument, I would generally recommend that [customers] have the warranty,” says Bilgin. “If it’s something basic, like a water bath, let’s say, then it’s maybe not as critical, but for something like a mass spectrometer that requires maintenance, I would recommend a warranty.”

Tula, on the other hand, always recommends a warranty. “It eliminates any gray areas, sets expectations, and establishes the chain of responsibility,” he says.

In addition to warranties, many vendors offer service contracts that come with their own set of benefits. “It’s hard to void a service contract,” Bragg explains, “but by moving the instrument or putting options on it or changing the location of the instrument, that may void the warranty. With a service contract, they would call us to do those things for them.”

As with warranties, when it comes to service contracts, numerous options are available. The service contracts offered by International Equipment Trading range from around $10,000 to $50,000. “It depends on how quickly you want onsite service, how many onsite visits you want included, and how much preventive maintenance you want,” explains Bilgin. The price of a service contract may also differ depending on the customer’s location, as labs in very remote places can be difficult for service providers to reach.

Tula recommends service contracts for mission-critical systems and break/fix time and material coverage for those items that serve a support role. “I would also recommend inspect-and-replace PM [preventive maintenance] inspections for non-mission-critical systems versus the more expensive full OEM-style PM services,” he adds.

According to Bragg, customers opting for service contracts are typically running production labs. “Production labs go for service contracts because they need to be producing samples every single day,” she says, “so they want to buy the insurance.” University labs, on the other hand, rarely have the budget for a service contract.

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Developing a Good HASP

A FRAMEWORK FOR EFFECTIVE INJURY AND ILLNESS PREVENTION

by Vince McLeod

The adage “hindsight is 20/20” should not be used for health and safety. In fact, prevention is the preferred modus operandi. Finding and fixing problems and hazards before employees are hurt is always the best approach.

Research shows prevention programs are effective at reducing workplace illnesses and injuries. Significant decreases are reported by leading companies that have adopted the preventive approach. In addition, transformation of safety culture usually follows. This positive change leads to higher productivity, reduced worker turnover, and greater employee satisfaction. Would you like a more successful health and safety program? Use a proactive approach to protect your employees and put a HASP on potential hazards in the workplace.

HASP, a health and safety plan template, contains essential elements developed by health and safety professionals based on research conducted by the National Safety Council.1 HASP represents a framework for building an effective injury and illness prevention program as promoted by OSHA2 and, in fact, is required in some states.

Hazard recognition, evaluation, and control

Hazard recognition, evaluation, and control make up the core of industrial hygiene and are key to a successful health and safety program. It starts with proactive hazard recognition in the environment (the surroundings of the workers), the people doing the work, the equipment and materials used in the work process, and the work processes/practices used.

A good initial step entails performing “job hazard analysis,” which assists with identification and is integral to many of the other elements listed below. For example, in a lab, the chemical hygiene plan calls for standard operating procedures that detail all the steps in a task or process. Once hazards have been identified and prioritized, control strategies are developed. The generally accepted hierarchy of controls is elimination/substitution, engineering controls, personal protective equipment, and administrative controls.

“It is critical that employees know what to do to perform their jobs correctly and safely.”

Workplace design and engineering

Designing safety into a workplace is as important as designing in efficiency, and they often go hand in hand. Building codes address certain areas (e.g., electrical standards, fire suppression, and egress requirements), but other aspects need conscious reflection. Examples include ergonomics, ventilation, noise controls for the anticipated work, equipment and machine safeguarding, materials handling and storage, use of automated processes, and added reserve capacity.

Motivation, behavior, and attitudes

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Great value should be placed on visible leadership from upper management and support for changing unsafe behaviors, attitudes, and work processes. Tip: Reinforce desired behaviors through recognition of positive actions.

**Training**

After we have identified and evaluated the hazards, we need to ensure adequate training for all employees. Use a variety of forms, from classroom style to hands-on, from general concepts to task-specific. It is critical that employees know what to do to perform their jobs correctly and safely. Tip: Develop a detailed orientation program for each different group to ensure initial training for specific tasks.

“It is very important to have a mechanism for staying informed and complying with existing regulations and standards.”

**Occupational health**

The nature and scope of a worker occupational health program is driven by the facility’s mission and work specifics. In research laboratory settings, one expects pre-employment health evaluations, periodic medical surveillance, injury protocols (e.g., for first aid, needle-sticks, and blood-borne pathogens), maintenance of medical records, and coordination among the departments when work-related health and safety issues arise. For example, coordination of respiratory protection and hearing conservation programs when both programs are necessary.

Accurate job descriptions are needed that take into consideration job duties (such as respirator or hearing-protection use or exposure to chemicals), especially those that trigger the need for pre-employment evaluations and medical surveillance.

**Regulatory compliance**

Research laboratories face regulations from OSHA, the EPA, and the DOT, and often accreditation or other agency-specific standards. Non-compliance can have serious ramifications in terms of financial liability (penalties and fines), institutional reputation, and, in some cases, the ability to continue operations. It is very important to have a mechanism for staying informed and complying with existing regulations and standards. It is also very important to keep abreast of new or evolving regulations that will impact operations. Tip: Perform a self-assessment or have an outside party conduct compliance audits at regular intervals.

Performance measurement should reflect how employees (management included) are doing compared with applicable regulatory require-
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Control and management of environmental and other external events

Environmental management is broad and complex, covering issues from proper permitting to preventing potential environmental liability. In addition, incident or emergency plans should be developed for severe weather, incidents stemming from contractor or “neighborhood incidents,” and issues such as protestors or activists.

Audits, record keeping, and reporting

This last essential element of a great HASP is focused on monitoring and measuring health and safety performance. It begins with good record keeping—a system of collecting and recording accidents, incidents, close calls, and injuries. Accurate information is critical for good decision making. In addition to requiring accident and injury reporting and collecting specifics, data needs to be analyzed and the results distributed to managers and others who need to maintain regulatory compliance.

Routine and regular health and safety audits, performed by in-house staff or committees or with outside consultants, should collect, analyze, report, and feed systems for improvement.

Those are the major components of a good HASP—a starting point for developing your own program, guaranteed to help reduce injuries and illnesses and pay healthy dividends in the long run.

Vince McLeod is an American Board of Industrial Hygiene-certified industrial hygienist and the senior industrial hygienist with Ascend Environmental + Health Hygiene LLC in Winter Garden, Florida. He has more than 35 years’ experience in industrial hygiene and environmental engineering services, including 28 years with the University of Florida’s Environmental Health & Safety Division. His consulting experience includes comprehensive industrial hygiene assessments of major power-generation, manufacturing, production, and distribution facilities. Vince can be reached at vmcleodcih@gmail.com.
Opioid-related deaths have dramatically increased in recent years, prompting officials to declare an opioid crisis. In the first three months of 2018, approximately 1,000 opioid-related deaths occurred in Canada, with 94 percent considered accidental. In 2017, there were more than 72,000 drug overdose deaths in the United States, a dramatic increase from previous years. Why the sudden, significant increase? Fentanyl. Of these accidental overdose deaths in Canada, 73 percent involved fentanyl or its analogs. Of the 72,000 in the United States, nearly 30,000 were attributable to fentanyl. Fentanyl is a powerful synthetic opioid that is 50- to 100-fold more potent than morphine. It has become popular among recreational drug users because it is relatively inexpensive and easily accessible. Unfortunately, many unsuspecting users consume fentanyl mixed into heroin or cocaine and suffer the lethal consequences. Opioids exert their effects through opioid µ-receptors, located primarily in the spinal cord and brain. Following receptor binding, fentanyl depresses the central nervous system (CNS) and respiration, potentially resulting in death. In cases of overdose, naloxone hydrochloride (Narcan) administration can alleviate CNS and respiratory depression through its antagonistic activity, allowing more time to seek medical assistance. Greater awareness of the dangers of fentanyl has led to increased availability of emergency naloxone kits, a small effort to address the growing problem.

THE PROBLEM WITH POTENCY

Bradley Urquhart, PhD, is an associate professor in the Department of Physiology and Pharmacology at Western University. As a trained pharmacologist, his research is focused on why patients respond to medications differently. His laboratory uses mass spectrometry to measure drug and metabolite concentrations and perform advanced metabolomics analysis to identify novel metabolites that predict patient response. According to Dr. Urquhart, fentanyl is “one of the drugs at the center of the [opioid] problem.” While fentanyl is very useful for the treatment of pain, it is “much more potent than some other opioids on the market.” Its potency makes it beneficial for pain management but can be very dangerous for unsuspecting street drug users. “When street drug users think they are buying a drug like heroin, it often also contains fentanyl.”

Bhushan Kapur, DPhil, CChem, FRSC, FACB, FCACBj, is the president of Clini Tox Inc. and has worked as a scientist in the Department of Clinical Pathology, Sunnybrook Health Sciences Center, and is an associate professor in the Department of Laboratory Medicine and Pathobiology at the University of Toronto. He also has acted as a consultant on toxicology at The Hospital for SickKids. He stresses the same point as Dr. Urquhart makes: the potency of fentanyl is especially dangerous. When used...
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in a clinical setting, fentanyl is administered in very small doses (usually in micrograms). When a street drug user purchases fentanyl, or another drug spiked with fentanyl, they aren’t aware of its potency and are at risk of overdose. He describes one of his first experiences with patients abusing fentanyl that occurred after he delivered a lecture and learned of patients extracting fentanyl from transdermal patches that were prescribed for chronic and severe pain. “Unfortunately, Fentanyl is just the start of the problem,” says Urquhart. “Analogs of fentanyl [molecules with very similar structure to fentanyl] have similar strength and can be even stronger than fentanyl.” These analogs also complicate testing, requiring forensic laboratories to update their analytical methods to detect known analogs. Given the dangers of fentanyl contamination of other drugs, there is an urgent need for accurate, sensitive testing strategies. Dr. Kapur explains that the first test for fentanyl was an immunoassay. It is highly sensitive and can easily detect the presence of a class of drugs such as opioids however, a lack of specificity means it is not suitable for separating the analogs in the sample. Chromatographic separation followed by mass spectrometry for detection enables greater specificity and can therefore be used to identify fentanyl analogs in a sample.

SEPARATION IS KEY FOR IDENTIFICATION

Scientists may use gas or liquid chromatography (GC and LC, respectively) to separate compounds in a sample. Gas chromatography often requires an inert gas as a mobile phase and a liquid or polymer layer in a column as a stationary phase. Similarly, liquid chromatography requires a mobile phase that often consists of a mixture of solvents such as water, acetonitrile, and methanol, and a stationary phase such as silica in the column. Liquid chromatography has recently become more common because it requires less extensive sample processing and extraction; however, “both GC and LC are used in toxicology laboratories,” says Kapur. “When coupled with a mass spectrometry [MS] detector, these methods are both sensitive and specific and can help in differentiation of the opiates.” Once compounds are separated by the GC or LC column, mass spectrometry is used to identify and quantify the presence of different compounds. A mass analyzer consists of an ion source, a mass analyzer, and an ion detector. When a sample enters the mass spectrometer from either gas or liquid chromatography, it is ionized by the ion source. The mass-to-charge ratio of ions within a sample is used to identify the chemical structure of the compounds. According to Dr. Kapur, tandem mass spectrometry (MS/MS) greatly increases the specificity of MS fragments because mass analysis occurs twice. “Once a precursor ion is isolated, it can then be fragmented again to produce product ions and neutral fragments.” Using LC-MS/MS, scientists are able to quantify drugs and compounds present at much lower concentrations, explains Dr. Urquhart. “The fact that a fragmentation pattern is used [by following transitions] allows the analyst to be reasonably certain that the molecule they see in their analysis is indeed the drug of interest. This is because they have several levels of evidence, including the chromatography retention time and how the molecule fragments when energy is applied.” Tandem mass spectrometry also aids in the resolution of compounds with “overlapping peaks that can or may not be separated by either of the separating methods,” according to Kapur. What’s more, Kapur affirms, when the
overlapping peaks have different molecular weights or structures, tandem mass spectrometry “helps in the resolution of these compounds.” Another detection method, LC-HRMS (liquid chromatography and high-resolution mass spectrometry), is “essentially taking it further and coming up with the molecular weight for use in identifying the compound,” says Kapur. This strategy is useful for identification of unknown drugs; however, “the sacrifice that HRMS instruments makes is that they have decreased sensitivity,” says Dr. Urquhart. “This means they are not able to measure concentrations as low as LC-MS/MS systems are.”

**CHALLENGES AND CONSIDERATIONS**

Chromatography coupled to mass spectrometry is certainly one of the most powerful tools for identifying fentanyl and its analogs in various samples. As with all analytical methods, there are some considerations and difficulties with the approach. “One of the biggest difficulties in identifying a compound is not having a library standard,” says Dr. Kapur. Analytical standards are pure compounds of known concentration. The presence of a specific compound in a sample can be confirmed by comparing the sample compound chromatogram to the analytical standard chromatogram. There are several online libraries with information and chromatograms for thousands of individual compounds; however, it is entirely possible that a compound of interest has not yet been added to a library and that an analytical standard is not available. In these cases, explains Dr. Kapur, a scientist can purchase a sample for analysis from a drug company and enter the resulting chromatogram into a reference library. Fentanyl and its analogs are uniquely challenging because “there often is very little or no information about the chemical formula and structure. In addition, analytical standards may not be available for purchase” says Urquhart. In these instances, the process of updating the reference library described by Dr. Kapur is often completed by forensic laboratories. According to Dr. Urquhart, these forensic laboratories are “often the ones identifying new analogs when they run tests on drugs seized by police. They are able to do this mostly by employing liquid or gas chromatography coupled to mass spectrometry.” Opioid abuse is a complex and growing problem. These drugs are potent pain relievers and are effective when prescribed following surgery or for other severe pain. However, they are often abused by patients who become addicted to their rapid, powerful effects. To further complicate the matter, street drugs such as heroin often contain unknown concentrations of fentanyl and its analogs with varying potency. As such, many recreational drug users have unknowingly consumed narcotics containing fentanyl and suffered an overdose. The severity and size of this problem have increased the need for accurate and reliable analytical methods for detecting fentanyl and various fentanyl analogs. Gas or liquid chromatography coupled to mass spectrometry enables scientists to tackle this challenge.

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Q: Can you provide some historical perspective on the application and development of mass spectrometry (MS) techniques and instruments for clinical research?

A: In the clinical world, gas chromatography-MS has been in use for a while, but it’s the advent of the triple quadrupole tandem MS that provided improved sensitivity and selectivity for analysis. The improvements had a big impact on clinical applications, such as for diagnosing a disease or finding biomarkers for research. It also enabled multiplexing, which helped researchers in this field monitor several analytes at the same time. For instance, more than 30 biomolecules or metabolites could be measured in a rapid screening, which becomes important when diagnosing many diseases in one sample for applications like newborn screening. The coupling of MS and chromatography with electrospray ionization made it easier to analyze almost any type of molecule, including nonvolatile samples, and this also helped us diagnose many rare diseases during newborn screening. The rapid development of tandem MS with an ion trap, we could identify and characterize the molecules, and imaging was used to look at their tissue distributions. Now as a faculty member in the department of pathology, I use a lot of those same approaches for clinical research. One of the advantages of imaging MS is that you can directly take a tissue sample and analyze what is present, which helps you avoid sample loss or changes in the analytes during an extraction. We are developing quantitative MS techniques that will enable us to look at target distribution in tissue that may be missed using extractive approaches.

MALDI enables you to identify a wide range of analytes, from small molecules and peptides to large proteins and biomolecules. As long as you can ionize it, you can analyze it. This has definitely helped quantitative analysis. However, one of the limitations of MALDI is that you have to coat the tissue with the matrix to get it ready for analysis. Hence, we have developed a spray chamber to coat multiple tissues with the matrix in a very rapid way to enable high-throughput studies. We are also working on developing techniques to avoid using MALDI and not have to coat the tissues. One of these techniques is the liquid microjunction surface analysis that we use to understand rapid changes in metabolites associated with Parkinson’s disease (PD). Here, we keep the tissue in a medium so that it remains in an active state and then rapidly analyze the changes that are taking place after electrical stimulation, a current treatment for PD.

We are also doing a lot of work related to understanding the microbiome. In one of the studies, we are using extractive liquid chromatography-MS to study the microbes that either inhibit or enhance tryptophan-mediated metabolism in a rodent model. The goal is to understand how the microbiome impacts tryptophan metabolism, which in turn affects various neurotransmitters and changes brain chemistry. Eventually we would like to use imaging MS to look at the distribution of the microbiome and study how the changes in distribution affect brain development.

Q: Can you provide details about your work in developing instrumentation and applications for imaging MS studies?

A: As an undergraduate in analytical chemistry, I started using matrix-assisted laser desorption/ionization (MALDI)-MS to look at protein signatures in bacteria and then, during my graduate work, developed MS-based imaging primarily for studying small molecules in tissue. Using the capabilities of tandem MS with an ion trap, we could identify and characterize the molecules, and imaging was used to look at their tissue distributions. Now as a faculty member in the department of pathology, I use a lot of those same approaches for clinical research. One of the advantages of imaging MS is that you can directly take a tissue sample and analyze what is present, which helps you avoid sample loss or changes in the analytes during an extraction. We are developing quantitative MS techniques that will enable us to look at target distribution in tissue that may be missed using extractive approaches.

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Q: What are the existing challenges and gaps in the use of MS in the clinic?
A: One of the biggest challenges in using imaging MS is still its throughput. An MS scan takes anywhere between 30 minutes to two hours and can take even longer depending on the size of the sample. There are new instruments under development that we’re using to try to speed up this process, but it’s still not as fast as looking under a microscope at a histology stain to identify what is present. Hence, developing faster imaging-based approaches for analysis will certainly help, but more important is finding ways to figure out whether imaging is really needed or not. The value of imaging, however, lies in the amount of information you can gather from each scan to help better understand the biological mechanisms. Imaging MS is information rich, containing several hundred molecules in a single mass spectrum.

It will take some time to translate imaging MS to routine diagnostic applications, and we may have to start with using it for cases where we have a problem using histology to make a diagnosis. Histology has been used for many years and has a large repository and knowledge base. Hence, one of the biggest advantages of histology is being able to go back and pull a tissue sample from years ago to compare it to the one you have today. Imaging approaches can also benefit from having such databases where you can compare tissue samples from the past to a scan that was recently generated. Creating data repositories for labs that do imaging MS will certainly help. Imaging MS is used in tandem with histology on tissue biopsies. With histology, you target a single analyte or a certain class of molecules, whereas with MS you can look at individual chemical signatures for many different analytes in the tissue. This gives a better understanding of the biology, which can help you understand different manifestations of the same disease and can lead to better treatment options. The other big trends in the field today are coupling imaging MS with NMR or MRI and developing stains or agents that will target new biomarkers.

Q: Any advice to our readers who are looking to explore the use of imaging MS?

A: One of the key things is finding opportunities to get adequately trained in using imaging MS through workshops at conferences like American Society for Mass Spectrometry (ASMS) or the Imaging Mass Spectrometry meeting. At these meetings, you can also learn new approaches that key leaders in the field are applying and make connections with people whom you can reach out to for assistance. Hiring people who already have the necessary experience will certainly help. Vendors have done an excellent job of developing the instrumentation, as well as the tools to analyze the data. Hence, reaching out to them to understand what the instruments are capable of and providing them with samples to analyze can help you see the possibilities that exist. With imaging MS, you get so much data on the chemical signatures that trying to figure out which chemical species is the most relevant to the question you are asking is very important. Finding the right software tools to help with data analysis and developing quality control protocols to make sure that a sample is handled in the same way, every time, ensures that the data is reliable.

As an MS consultant, I find that some of the common problems are associated with finding out when the instrument is not working properly. Helping people find ways to quickly figure out whether the problem is with the instrumentation, with sample preparation, or with different components along the way, becomes important. How to maintain the quality data or the analysis is also of concern to most people. When starting a new lab, there are always questions around how to routinely maintain the MS or how to build a lab that enables you to effectively use MS. It’s often the little details that make a big difference.

Timothy Garrett received his undergraduate degree in chemistry from the University of Georgia, graduating summa cum laude. As an undergraduate, he worked in the lab of Dr. I. Jonathan Amster on the characterization of bacterial proteins using MALDI-TOF. After two years in industry, he enrolled in the PhD program at the University of Florida, working under the direction of Dr. Richard A. Yost. As a graduate student, he worked on the first imaging mass spectrometry-based ion trap instrument through a partnership with Thermo and studied the disposition of phospholipids in brain tissue. He is currently an associate professor in the Department of Pathology at the University of Florida, where he is associate director of the Southeast Center for Integrated Metabolomics (SECIM). His current interests are the application of direct tissue analysis approaches such as MALDI, DESI, and LMJ-SSP, as well as the use of high-resolution mass spectrometry in metabolomics and routine diagnostics. He enjoys the interplay between technological advancement and clinical analysis, believing they provide unique opportunities to develop future diagnostic tools.

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LC-MS-BASED METABOLOMICS

by Brandoch Cook, PhD

We tend to think of the long course of medical history before the advent of conveniences like anesthesia, antibiotics, and vaccines as the Dark Ages—a vast epoch dominated by superstition when otherwise sober professionals addressed illness and outbreak by applying trepans and scarificators, venting humors and spleen. The truth is, however, more complicated, with plenty of evidence of human perspicacity before industrial and technological revolutions took hold.

One interesting case in point is the diagnosis of some metabolic diseases, understood for at least 3,000 years to manifest themselves in the color, smell, and taste (!) of urine. The disruption of glucose metabolism in diabetics has long been identified using sweet-tasting urine as a surrogate, a precursor to today's biomarkers that was independently noted by ancient Greek, Arab, and Chinese cultures. It was codified along with other observations concerning color and odor—their merits and portents—in a urine wheel that marked perhaps the first published application of the scientific method in medicine, Epiphanie Medicorum, in 1506.

“Metabolomics resides atop a Mount Rushmore of ‘omics’ disciplines.”

The necessity for tasting bodily fluids began to dwindle with the rise of gas chromatography, which allowed the first reproducible separation and identification of individual volatilized compounds on the basis of molecular mass by pushing them within a mobile gaseous column over a stationary, nonvolatile solvent. James and Martin used this principle to separate fatty acids in the early 1950s. Linus Pauling’s research group was later among the first to identify the potential for this technology to impact medicine. He and his colleagues demonstrated the collection, concentration, and separation of volatile compounds from human breath and urine samples in a 1972 paper. Thus, the field of metabolomics was born.

Metabolomics is the study of the sum total of small molecules in biological samples, and therefore aspires to provide an accurate snapshot of homeostasis, or of pathological dysfunction, within a given biofluid, cell, or tissue. Metabolites are entities with molecular weights of less than one kilodalton and can encompass many different classes of molecules, including peptides, amino acids, lipids, protein degradation intermediates, and exogenous compounds acquired through ingestion, inhalation, or drug metabolism.

Metabolomics resides atop a Mount Rushmore of “omics” disciplines, along with genomics, transcriptomics, and proteomics. Among them, it is: 1) the most amenable to continued innovation and optimization; and 2) perhaps the most potentially useful for precision and personalized medicine because of its intrinsic ability to characterize and quantify phenotype. Present studies and future goals seek to achieve the following: 1) improve technology, protocol, and instrumentation to allow higher accuracy and throughput; 2) provide comprehensive molecular signatures that can define cell and tissue types, especially for systems biology analysis; 3) identify and quantify biomarkers that can lead to early prediction and diagnosis of disorders including cancer and diabetes; and 4) refine drug discovery and pharmacokinetic studies that can lead to novel drug candidates and save essential resources early in preclinical and clinical testing of dosage and safety.

Although it is not currently feasible to measure the entire metabolome using a single analytical method, innovation and variation in techniques have brought about drastic improvement in throughput and fidelity, with advances in execution and scale among the three parent platforms that can be used in metabolomic studies. Proton nuclear magnetic resonance (NMR) allows direct measurement of compound spectra within a sample. Although data from NMR is highly reproducible, the complex nature of biological samples causes this method to lack resolution and throughput in comparison with mass spectrometry (MS) methods. Both gas chromatography (GC) and liquid chromatography (LC) precisely quantify the composition of ionized analytes based on mass-to-charge ratios and require column-based separation of samples before analysis. Different separation methods govern procedures depending on variables including size and polarity of metabolite classes of interest. GC-MS is fundamentally more limited in its scope because not
all samples can be accurately measured in a volatilized form. In contrast, LC-MS accommodates liquid and solid samples, highlighting its use in metabolic studies that are often based on cells and biofluids such as urine, blood, and plasma.

Therefore, the gold standard in metabolomics currently runs through LC-MS, in which samples are most often subjected to electrospray dual ionization to generate both positively and negatively charged species. The LC step is the most important in the sense that sample preparation and subsequent separation consume the most time and introduce the most variability into analysis. There are several different versions of LC that are optimal for separation of different types of metabolites, including: 1) reverse-phase liquid chromatography, which uses hydrophobic columns to separate semi-polar molecules such as phenolic acids, flavonoids, and glycosylated compounds; 2) hydrophilic interaction liquid chromatography, which uses aminopropyl columns to separate polar compounds such as sugars, amino acids, and vitamins; 3) multidimensional liquid chromatography, which uses two or more independent separation techniques to maximize coverage; and 4) ultra-pressure liquid chromatography, which is a variation that has gained preference because its doubling of flow rate and halving of particle size in the stationary phase allows for higher resolution in large-scale metabolomics studies.

The potential of LC-MS-based metabolomics is immense, as is the associated cost of dedicated instrumentation. For researchers and core facilities with a dedicated interest in metabolomics, manufacturers have begun to innovate equipment with both greater throughput and smaller footprints, especially on the front end of LC-mediated separation. One of the most appealing examples of this is the StreamSelect system by Agilent (Santa Clara, CA), which allows parallel separation via four independent LC devices that stream into one quadrupole mass analyzer. One advantage of this system is that it avoids the frequent sample and data loss issues that can plague LC-MS runs, allowing for samples to be diverted to functional streams while compromised ones are repaired on the fly. Finally, improvements in LC-MS technologies have funneled into a growing industry, with open-source informatics databases like HMDB and METLIN providing broad coverage of known molecules and standards, and the evolution of at-home and in-office omics service contractors such as Metabolon providing metabolomics-based precision medicine to institutes, patients, and consumers.

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“The potential of LC-MS-based metabolomics is immense, as is the associated cost of dedicated instrumentation.”
ESTIMATING PARTICLE SIZE USING DISTRIBUTIONS

by Erica Tennenhouse, PhD

The ability to measure particle size is crucial when it comes to certain types of products. Particle size helps determine the appearance of paint, the flavor of cocoa powder, the strength of cement, the properties of die filling powder, the absorption rates of pharmaceuticals, and the appearance of cosmetics, according to Horiba’s guidebook to particle size analysis. Determining particle size enables industries to control the quality of their products, optimize manufacturing efficiency, and achieve compliance in regulated markets.

Spherical equivalents

When trying to assess particle size, researchers routinely measure particle diameter, the assumption being that all dimensions of the particles in question are identical. The many measures that factor into the size of a sphere—its perimeter, projected cross-sectional area, surface area, and volume—can be described unambiguously by diameter. Furthermore, the diameter of a sphere remains constant regardless of the angle of view.

However, things quickly become complicated when particles are not perfectly spherical. Other than a sphere, no regular or irregular shape projects the same cross-section at all angles. That means neither surface area nor volume can be inferred from the cross-section of a nonspherical particle.

One way to describe the size of nonspherical particles is by using multiple horizontal and vertical measures; however, such descriptions are complex. Therefore, it is common for researchers to assume that all particles in a sample are spherical and to report the value as a one-dimensional sphere-equivalent by determining the size of the sphere that could have produced the values obtained by scattered light, settling rate, or other methods.

The need for distributions

Obtaining the spherical equivalent, however, is less than ideal in certain situations. For irregular shapes with large aspect ratios, such as rods and fibers, size can differ significantly depending on which dimension you measure. To deal with this issue, samples are often represented as distributions of sizes. In its white paper on the topic, Malvern Instruments Limited (Worcestershire, UK) outlines several types of particle size distributions, which include:

• Number-weighted distributions: counting techniques such as image analysis can enable each particle to be weighted irrespective of its size.

• Volume-weighted distributions: static light-scattering techniques such as laser diffraction yield volume-weighted distributions, where the relative contribution of a particle is proportional to its size.

• Intensity-weighted distributions: dynamic light-scattering techniques yield intensity-weighted distributions, where each particle’s contribution to the distribution is related to the intensity of light scattered by the particle.

Depending on which type of distribution is being used to measure particle size in a sample, one might get widely different results; for example, a volume-weighted distribution based on image analysis will not necessarily match a distribution based on laser diffraction.
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Conversion of data from one type of distribution to another can be done, but it requires assumptions to be made about the physical properties of the particles.

With a distribution in hand, the next task is reporting results. Depending on the information required, several descriptive statistics may be suitable. The mean, median, and mode all describe the central value of the distribution. Standard deviation and coefficient of variation describe the width of the distribution. Ideally, a central value will be combined with a width measure to give the most complete picture of the particle sizes represented by the distribution.

**It’s not all about size**

In addition to particle size, certain industries are interested in measuring particle shape, which has been described as “the second variable of the particle characterization equation.” Advanced imaging techniques are providing those industries with crucial information needed to supplement their size distributions with greater details about the shapes of the particles in their samples.

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X-RAY FLUORESCENCE ON THE MOVE

by Mike May, PhD

To analyze the elements in a sample, scientists can use X-ray fluorescence (XRF), which can be performed with a benchtop or portable platform. Each option offers its own benefits and shortcomings.

The key benefit of portable XRF is in the name—portable. “Most portable systems can be run from a battery pack, making them flexible for use in virtually any location,” says David Fleming, professor of physics at Mount Allison University (Sackville, New Brunswick, Canada).

“The main difference between portable XRF and benchtop instruments is the power,” says Edenir Rodrigues Pereira-Filho, a chemist at the Federal University of São Carlos in Brazil. “Consequently, the sensitivity will be affected.”

The highest power and sensitivity come in benchtop XRF platforms. Still, Pereira-Filho notes that “portable XRF is suitable for fast alloy identification and to analyze a material for the presence of a specific element.” But that works only if enough of the element is in the sample. “If the concentration is around two to 10 percent or higher, it is possible to obtain results with relatively good accuracy,” he explains.

Sample preparation is also easier with the portable approach. “The sample can be measured intact and nondestructively, so you will have the sample for future measurements as well,” says Aaron Specht, research fellow at the Harvard T.H. Chan School of Public Health (Boston, MA). Even if using a sample as is, “typical portable XRF systems have detection limits of parts per million or slightly less,” he says.

There are certain inconveniences associated with benchtop XRF, says Pereira-Filho. “Depending on the instrument, the sample must be cut in order to fit inside the sample chamber.”

To measure elements at lower levels, scientists need a benchtop XRF platform or other method, such as inductively coupled plasma-mass spectrometry (ICP-MS). For example, Pierre Masson, director of the Unit of Research and Service in Plant and Environmental Analyses at the Centre de Recherches INRA de Bordeaux (France), and his colleagues used lab-based XRF to analyze elements in plant samples, and found it faster than ICP-MS.

In some cases, though, portability really helps. “Portable XRF systems can be better for applications where factors such as cost, speed of results, and capability for on-site measurement are critical,” says Fleming.

Applications of portable instruments

The range of uses of portable XRF continues to expand. For Specht’s doctoral thesis, he adapted portable XRF to measure lead in human shinbones. “We were able to develop a calibration to accurately measure lead in people’s bones in three minutes by simply placing the portable XRF on their shin with our special equipment settings,” he says. “Since bones are a slow-growing organ, for adults one measure of bone lead can give us information on their lead exposure from the past 20 to 30 years.” Specht and his colleagues have used this method in studies of lead exposure in humans and wildlife.

Fleming’s research group is currently testing a portable XRF approach to assess levels of various elements in human toenail clippings, he says. “In the future, a portable XRF approach for this type of application could be especially useful, as it would return results to individuals quickly and at low cost.”

Specht works with lab-based methods of element detection, including ICP-MS, to find ways to make portable XRF as effective as possible. “Ultimately, portable XRF still has the limitations in detection limit, but with more powerful systems, it can be used in many more applications than previously thought.”

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TITRATION IN WINE ANALYSIS

by Angelo DePalma, PhD

Winemaking begins with ordinary fruit and ends, sometimes decades later, with a solution of hundreds of identifiable acids, esters, salts, small molecules, and, of course, ethyl alcohol. Although basic viticulture and fermentation have been around for millennia, modern technology—including analytic instrumentation—has greatly improved consistency and quality. High-end producers tout the uniqueness of their grape blends, growing conditions, and, above all, how grapes are processed and turned into $2,000-per-bottle Chateau Lafite Rothschild. As with all process industries for high-value products, for winemakers the process is the product.

Yet in a manufacturing environment, producers are limited to studying just a fraction of the ingredients contributing to a vintage’s characteristic taste and quality. In this age of readily available high-end analytics, vintners remain interested, by and large, in a handful of diagnostic parameters, among them titratable acidity, volatile acidity, and free and total sulfur dioxide, all of which are accessible through titration.

That’s not to say that more sophisticated approaches to assessing wine quality are not used. Liquid chromatography–mass spectrometry, for example, provides a signature spectrum of volatile and semi-volatile taste and quality attributes. Bruker (Billerica, MA) has an application note on nuclear magnetic resonance analysis for profiling these components, and inductively coupled plasma has been a mainstay for oenologic elemental analysis since at least the 1980s.

Analytics and reality

Unfortunately, for most commercial wineries competing in increasingly global markets, gas chromatography or liquid chromatography is impractical. “The acquisition cost of these instruments is prohibitive, maintaining staff knowledgeable enough to run those instruments is unrealistic, and there are alternative benchtop, wet-chemistry analytical methods that meet their needs just as well,” says Maureen Moroney, research associate at the Midwest Grape and Wine Industry Institute (Ames, IA).

Titratable acidity is more related to the consumer’s sensory perception of wine. “Once the wine has finished

“Titrator methods, including associated sample preparation, vary depending on what is being analyzed, but the principle of titrating to an end point is always the same,” Moroney says. Variability extends to the degree to which methods are automated. Small winery labs often perform titrations manually, and conduct the tests during production and afterward as a quality check. “Volatile acidity and sulfur dioxide are both major quality parameters for wine, with legal limits set by the Alcohol and Tobacco Tax and Trade Bureau [TTB], a unit of the U.S. Department of the Treasury.”

Constantly evolving parameters

“Wine producers need to keep an eye on product during processing because the chemistry of juice and wine is in constant flux until the product is finished, and even beyond that. No two batches are the same, so there is no formula for consistent quality,” Moroney continues. “In-process testing helps guide decision-making on the next process step [and] helps detect problems early, with the potential to intervene appropriately.”

For example, sharply rising volatile acidity during fermentation indicates that microbes such as acetobacter, which produce acetic acid (vinegar) and ethyl acetate, may have entered the system or that the batch has been exposed to oxygen.

For sulfur dioxide (SO₂), an additive present in most commercial wines that prevents oxidation and microbial spoilage, free SO₂ is protective whereas the bound chemical is not. Winemakers must therefore balance fixed and free SO₂, the concentrations of which they determine through titration.
fermentation and/or malolactic conversion, it tends to remain fairly stable unless other interventions are made; for example, acidification, deacidification, or cold stability achieved by precipitation of potassium bitartrate,” Moroney notes. “Of the three parameters, titratable acidity is probably measured least frequently, especially as many winemakers tend to rely more heavily on pH measurements for decision-making.”

“Vintners use titration throughout the entire production process,” says Lori Spafford, titration product manager at Metrohm USA (Riverview, FL). “It lets you check raw ingredients—you can check the batch while fermentation is taking place and as a final quality control [QC]. The same titration that is performed during production is also used as a final QC test.”

**What to consider**

As with pharmaceuticals, regulators outline in detail what they expect from quality and wholesomeness testing, but they do not mandate or even recommend specific methods. The American Society for Enology and Viticulture, which has no formal regulatory or legal status, recommends the Ripper method for free SO₂ and titration-based aeration-oxidation methods to complement segmented flow analyzers, enzymatic assays, colorimetric analyzers, flow injection analysis, and Fourier-transform infrared spectroscopy.

Winery laboratories have wider latitude with respect to which instrument they buy; but in addition to basic titration, they need to consider how a system keeps records, how it connects to computers and other instrumentation, and the instrument’s throughput. Once purchased, the cost of consumables and (excluding depreciation) the price per test will be very similar for different systems, according to Moroney.

“Instrument cost is a major factor, but winery labs should also consider which parameters they’re planning to test for—some titrators can be set up for multiple analytes. Users should also consider the user interface, the expected throughput, and the availability of service and support from the instrument’s vendor.

Spafford advises potential buyers to consider a system’s modularity, its ease of use, and the vendor’s experience. “Having a titration system that will handle today’s workload, but [that] can easily be expanded by adding modules, is important for the growing winery business. User friendliness is important because winery lab staff is sometimes seasonal. Also, doing business with a vendor with decades of experience titrating wine will help you ensure that any question, challenge, or need you have will be met when it matters the most.”

Metrohm has lately focused its titration efforts on high-throughput instrumentation, an important consideration for any industry that should keep an eye on processes in real time but always seems to find an excuse not to. The company’s OM-NIS titrator line promises greater efficiency and throughput.

So, with all the instrumentation in the world at their disposal for in-process and post-production quality-checking, why do we never hear about large winemakers discarding 100,000-liter batches?

Mostly because it rarely happens. “There is typically no rejecting a batch of wine,” Moroney explains. Wine failing to meet quality standards may be blended into other products or sold on the bulk market. “Because wine is low risk in terms of consumer safety, and because many small wineries simply can’t afford to dump a significant portion of their stock in a given year, a flat-out rejection is almost unheard of.”

Think about that before purchasing your favorite wine in a box or that $100 “vintage of the century.”

Angelo DePalma is a freelance writer living in Netcong, New Jersey. You can reach him at angelo@angelodepalma.com.

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

product focus | titrators
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Test your knowledge of science trivia and win great prizes.

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Why Philadelphia is the Perfect Fit

Top Technologies for 2019

What to see, where to eat, must-attend events, and more
The annual Pittsburgh Conference is the place to be if you want to learn more about cutting-edge research in the fields of analytical chemistry and molecular biology. This year’s conference and expo will be held in Philadelphia, Pennsylvania—a location that makes perfect sense. Why, you may ask? Because science is in its DNA.

Not only was America’s first hospital founded in Philadelphia, but also its first medical school, first children’s hospital, first college of pharmacy, and first medical library. Since then, the city has grown into one of the top life sciences sectors in the country with more than 11 million square feet of life science real estate. Philadelphia is currently home to more than 800 life science companies with over 49,000 employees. Impressively, SmartAsset also ranked the city as the best in America for diversity in science, technology, engineering, and math (STEM) fields.

During your free time, discover the rich history of science in Philadelphia for yourself at one of the many medical and science attractions. Founded in 1812, the Academy of Natural Sciences of Drexel University offers many exhibits including dinosaurs, butterflies, and mythical creatures. You can also explore 19th century anatomical specimens, models, and medical instruments at the College of Physicians of Philadelphia’s Mütter Museum. Still looking for something to do? Visit some of the interactive exhibits at The Franklin Institute. Founded in 1824, the Institute aims to promote the spirit of inquiry and discovery embodied by its namesake, Benjamin Franklin.

Still not convinced? In addition to its vital role in establishing the field of life science in America, Philadelphia is also ranked No. 4 of the Top 20 Destinations in U.S. cities for medical meetings, according to the 2013 State of the Industry Report issued by the Healthcare Convention Exhibitors Association (HCEA). Add in the many acclaimed restaurants and entertainment options and this is sure to be a conference like no other.
**Pittcon AGENDA**

**MONDAY MARCH 18, 2019**

**LABCONCO (Room SC034)**

**Short Course:** Ventilated Lab Hood Selection and Implementation: Learn about fume hoods, ductless hoods, biosafety cabinets, balance enclosures, glove boxes, and how they all affect the airflow and personnel protection in your lab.

**PHOTO OPS** Arriving early for the Expo® Snap some iconic photos at one of these Philadelphia landmarks.

- **The Liberty Bell Center**
  Visit the icon of freedom and see for yourself the famed crack created by the 44-pound clapper upon the first ringing of the bell.
  Market St, Philadelphia, PA | 9 am – 7 pm

- **LOVE Park**
  The park houses Robert Indiana’s famous Love sculpture and serves as the grand entrance to the Benjamin Franklin Parkway.
  Arch St, Philadelphia, PA

- **The “Rocky Steps”**
  Take a picture with the Rocky statue at the bottom of the stairs and then snap a photo of yourself running up the steps featured in the movie Rocky I.
  2600 Benjamin Franklin Pkwy, Philadelphia, PA

**TUESDAY MARCH 19, 2019**

**COFFEE SHOPS** Start the day off right with coffee from one of Philadelphia’s local coffee shops.

- **Elixr Coffee Roasters**
  315 N 12th St, Philadelphia, PA | 7 am – 6 pm

- **Old City Coffee**
  Simple spot offering coffee roasted in-house plus a menu of soups, bagels, milkshakes & more.
  1200 Filbert St, Philadelphia, PA | 8 am – 6 pm

- **Square One Coffee Roasters**
  Bright cafe serving espresso made from signature beans, plus specialty drinks & baked goods.
  1811 John F Kennedy Blvd, Philadelphia, PA, 7 am – 4 pm (Weekdays)

9:00 **Pittcon Expo Opens**

10:00 - 12:30

**MilliporeSigma (Booth #2318, 2319)**

**Presentation 1:** Next-generation TOC monitor for ultrapure water purification systems.

**Presentation 2:** Innovative mercury-free UVC-LED reactor for bacteria control in purified water.

11:00 **LABX MEDIA GROUP (Booth #1955)**

Pick up your copy of Lab Manager Magazine, test your trivia knowledge, win great prizes, and don’t forget to pick up your Linda or Lenny USB featuring the latest Lab Manager Linda Videos.
### MILESTONE: DEMOZONE AREA 1 (Booth #3242)
Setting the Standard for Direct Mercury Analysis with the Milestone DMA-80 evo.

### BRUKER (Booth #2754)
Hands-on demos for Senterra II Raman microscope and LUMOS IR microscope and will run customer samples (appointments to be scheduled upon request).

**Lecture:** State-of-the-Art Microanalysis using Infrared and Raman Microscopy.

### KNF NEUBERGER (Booth #1120)
Visit KNF to see their latest laboratory products. Ask an expert about selecting the right LABOPORT vacuum pump for your application. Discover KNF LIQUIPORT transfer and SIMDOS dosing/metering liquid pumps. Or, explore KNF rotary evaporators. While at the booth, enter their “Count the Skittles” contest for your chance to win a universal wireless cell phone charger!

### LABCONCO: DEMOZONE AREA 2 (Booth #3042)
Automated Approach to Volumetric Pipette Cleaning.

### PITTCON BOOTHS (Booth #2625 & #4142)
Stop in to check out the photo booth, Gauntlet card drop off, giveaways, and luggage tags.

#### DINNER
At the end of the day, catch up with colleagues over dinner at one of the many nearby restaurants.

<table>
<thead>
<tr>
<th>Restaurant</th>
<th>Location</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bank &amp; Bourbon</td>
<td>1200 Market St, Philadelphia, PA</td>
<td>11:30 am – 1 am</td>
</tr>
<tr>
<td>El Vez</td>
<td>121 S 12th St, Philadelphia, PA</td>
<td>10:30 am – 11 pm</td>
</tr>
<tr>
<td>Nan Zhou Hand Drawn Noodle House</td>
<td>1022 Riva St, Philadelphia, PA</td>
<td>11 am – 10 pm</td>
</tr>
<tr>
<td>Nom Wah Philadelphia</td>
<td>218 N 13th St, Philadelphia, PA</td>
<td>11:30 am – 10 pm</td>
</tr>
<tr>
<td>Sang Kee Peking Duck House</td>
<td>238 N 9th St, Philadelphia, PA</td>
<td>10 am – 9:30 pm</td>
</tr>
<tr>
<td>Smokin’ Betty’s</td>
<td>116 S 11th St, Philadelphia, PA</td>
<td>11 am – 10 pm</td>
</tr>
</tbody>
</table>
LAB GAUNTLET (Pittcon Park)
Test your lab skills on a variety of fun but challenging lab activities. Prizes will be awarded daily for the best scores. Those who run the gauntlet will receive a t-shirt.

CEM (Booth #3327)
Stop by CEM and check out the newest technology for microwave digestion or trace elemental sample prep, the MARS 6 Microwave Digestion System.

HORIBA: DEMOZONE AREA 1 (Booth #3242)
Analysis in the Nano Age: Advances in nanoparticle identification, quantification, and sizing by nanoparticle tracking. See a demonstration of sample preparation, measurement, and result analysis with multi-laser nanoparticle tracking analysis.

LUNCH For lunch, walk across the street to the historic Reading Terminal Market. Opened in 1892, this market boasts more than 80 vendors and was recently named the Top Farmers Market in the Country.

By George!
Busy Italian stand at the Reading Terminal Market with brick-oven pizza, cheesesteaks & other bits.
8 am – 6 pm

Dutch Eating Place
Pennsylvania Dutch counter in Reading Terminal Market offering homestyle breakfasts & lunches.
8 am – 5 pm weekdays

Carmen’s Famous Italian Hoagie
Busy cash-only counter inside the farmer’s market selling hoagies, Italian subs & cheesesteaks.
8 am – 6 pm

BRUKER (Booth #2754)
Lecture: Mobile Lab Concept – Attendees are welcome to bring samples to test. Testing will be on a come-first serve basis.

EXPO MIXER (Pittcon Park)
Take a break from your busy day to enjoy snacks and refreshments.

VACUUBRAND: DEMOZONE AREA 2 (Booth #3042)
Come experience the new and easy to use VACUU·SELECT® vacuum controller. This touchscreen controller is as intuitive as your smartphone and comes loaded with applications covering all common lab vacuum processes.
## THURSDAY MARCH 21, 2019

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00</td>
<td><strong>CLIPPARD (Booth #1444)</strong> Stop by Clippard and view some of their 6,000+ standard products and find out how they can design or modify to suit a particular need.</td>
</tr>
<tr>
<td>10:00</td>
<td><strong>BRANDTECH SCIENTIFIC (Booth #1028)</strong> Stop by the booth to check out the latest BRAND pipetting robots and liquid handling products.</td>
</tr>
<tr>
<td>1:00 - 2:00</td>
<td><strong>CEM: DEMOZONE AREA 1 (Booth #3242)</strong> Simple extraction for liquid and gas chromatography sample preparation.</td>
</tr>
<tr>
<td>1:30 - 2:30</td>
<td><strong>MILESTONE: DEMOZONE AREA 2 (Booth #3042)</strong> Single Reaction Chamber [SRC] Microwave Digestion with the Milestone ultraWAVE.</td>
</tr>
<tr>
<td>4:00</td>
<td><strong>FRITSCH (Booth #3005)</strong> Stop by FRITSCH to see their automated mortar grinder for analysis, materials testing, mixing and homogenization of pastes and creams, the Pulverisette 2.</td>
</tr>
</tbody>
</table>

### 5:00 Pittcon 2019 Expo closes

#### WHAT TO SEE
Take a break from the conference festivities, or extend your stay and visit one of the many historic attractions located in the heart of Philadelphia.

- **Benjamin Franklin Museum**
  Dedicated to the famous founding father, the museum uses artifacts, computer animations, and interactive displays to explore Benjamin Franklin’s life.
  317 Chestnut St, Philadelphia, PA | 9 am – 5 pm

- **City Hall and City Hall Tower**
  The largest municipal building in the United States took 30 years to complete and is considered an architectural treasure.
  1400 John F Kennedy Blvd, Philadelphia, PA | 8 am – 5 pm

- **Independence Hall & Carpenters’ Hall**
  This historic venue hosted the signing of the Declaration of Independence and the US Constitution.
  520 Chestnut St, Philadelphia, PA | 8:30 am – 5 pm

- **One Liberty Observation Deck**
  The indoor observatory on the 57th floor of a skyscraper offers 360-degree views of Philadelphia.
  1650 Market St #5700, Philadelphia, PA 19103, USA | 10 am – 8 pm

- **Pennsylvania Academy of the Fine Arts**
  View the works of some of the nation’s most talented contemporary artists at the country’s oldest art museum and school.
  118-128 N Broad St, Philadelphia, PA | 10 am – 5 pm

- **Race Street Pier**
  Located on the Delaware River, the pier is illuminated at night by over 200 LED Solar Light Blocks embedded into the paving.
  N Christopher Columbus Blvd, Philadelphia, PA | 7 am – 11 pm

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For over 100 years, Carver hydraulic presses have set the standard for laboratories around the world for nearly any application.

www.carverpress.com

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CEM is a leading provider of sample preparation equipment for spectroscopic and chromatographic analysis.

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www.milliporesigma.com

PARKER
www.labgasgenerators.com

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www.polyscience.com

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Pittcon PRODUCT ROUNDPUP

If your lab identifies, quantifies, analyzes, or tests the chemical or biological properties of molecules or compounds, then these are some of the must-see products featured at Pittcon 2019.

LABCONCO: FREEZONE TRIAD
The FreeZone Triad Benchtop Freeze Dryers offer it all for lyophilization: stoppering tray dryer and sample freeze drying with four sample valves on the left side. Samples for both types of freeze drying can be run at once. The chamber pre-freezes samples to save money and time, eliminating the need for a separate freezer and product transfer.

www.labconco.com/category/freezone-triad-freeze-dryer

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www.labconco.com/category/freezone-triad-freeze-dryer

OHAUS: FRONTIER 5513 HIGH-SPEED MICRO CENTRIFUGE
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product round up

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www.horiba.com/scientific/products/particle-characterization/

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The H2PEMPD is an excellent source of ultra-pure, dry hydrogen used to provide fuel gas for chromatographs, producing up to 1300 cc/minute of pure fuel and carrier gas at up to 175 psig.


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https://milestonesci.com/ultrawave-microwave-acid-digestion-system/

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product round up

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The new, easy-to-use VACUU-SELECT® controller features an application-based touchscreen interface that covers all common lab vacuum processes. Use the preloaded applications or create your own with the drag-and-drop editor. – Integrated into the PC 3001 VARIO® select pump, you can run fully automated evaporation at the touch of a button. The VACUU-SELECT controller continuously detects solvent boiling and automatically adjusts the pump’s motor speed to maintain process control, minimizing process time while preventing bumping and foaming.

www.vacuubrand.com/en/page1380.html

MilliporeSigma: MILLI-Q® IQ 7003/7005
MilliporeSigma has completely redesigned its flagship Milli-Q® product, launching the new Milli-Q® IQ 7003/7005 ultrapure and pure lab water system. Now more easy-to-use, compact and sustainable, this fully-integrated system delivers consistently superior quality Type 1 & Type 2 water directly from tap water.

ICP-MS SOLUTION
BOOTH 3010
- Puts the power of trace multi-element analysis in the user’s hands by simplifying and optimizing the typical ICP-MS workflow
- Ideal for high-throughput laboratories seeking the perfect mix of performance and ease of use
- Unique 90° quadrupole deflector ensures the analyzer and detector are not in line with the plasma beam
Advion
www.advion.com

Oxygen Permeation Analyzer
OX-TRAN® 2/40
BOOTH 3234
- Targets package permeation testing for food, beverage, and healthcare packaging applications
- Accurately tests whole packages for oxygen transmission rate (OTR) values at controlled humidity and temperature conditions
- Uses next generation software platform with automated controls and simple touchscreen display
AMETEK MOCON
www.mocon.com

Spectrophotometers
Jenway®
BOOTH 2229
- Split beam technology improves accuracy and repeatability when determining samples
- Safely and securely upload and archive data to the cloud, manage multiple devices at one time with the CPLive app, share data with colleagues, and access unlimited data storage
- Ideal for a variety of applications from teaching, to industrial applications, to routine sample analysis in quality control environments
Cole-Parmer
www.coleparmer.com/Jenway

Gas Chromatograph
FROG-5000™
BOOTH 4034
- Uses ambient air as the carrier gas, enabling easy and rapid analysis of volatile organic compounds on site
- Analyzes soil, air, or water for contaminants like benzene, toluene, ethylbenzene, xylene, and trichloroethylene
- Produces lab quality results in less than 10 minutes
Defiant Technologies
www.defiant-tech.com

Carbon/Sulfur Analyzer
ELEMENTRAC CS-d
BOOTH 2611
- Carbon and steel are measured simultaneously with an accurate infrared detection system
- Up to four measuring cells can be customized according to the user’s requirements
- Comes with comprehensive, Windows-based ELEMENTS software
ELTRA
www.eltra.com

Discrete Analyzer
Smartchem450
BOOTH 2041
- Maximizes productivity for routine and special chemistries with up to 450 tests/hour
- Features new and improved software, and is fully automated
- Combines multi-parameter analyses on many samples with ready-to-use reagents for low running cost
AMS Alliance
www.amsalliance.com

Gas Analyzer
MAX300-CAT
BOOTH 2532
- Suitable for catalysis, reaction monitoring, and environmental research
- Performs high precision quantitative analysis of every component in a gas or vapor mixture
- Can be equipped for the fully-automated sampling of up to 16 gas channels
Extrel CMS
www.extrel.com

Particle Analysis System
Bettersizer S3
BOOTH 1031
- Combines dual lenses and oblique incidence optical system (DLOIS) for a wide testing range and dynamic image analysis for shape results
- Provides smart operation system and software for quick and reliable measurement
- Ensures accurate results with high resolution, high sensitivity, and excellent repeatability
Dandong Bettersize Instruments, Ltd.
www.bettersize.com.hk

Particle Size Analyzer
MAJSx²
BOOTH 3710
- Designed for determining the particle size distribution of dry powder ranging from 20 to 4,750 μm
- Suitable for the chemical, mined, pharmaceutical, food, plastic, and cosmetic industries
- Data can be transferred to LIMS system as a CSV file
Hosokawa Micron Powder Systems
www.hmicronpowder.com
**Thermogravimetric Analyzer**
**TGA801**
**BOOST 3127**
- Designed to maximize the user’s productivity and improve workflow
- Ideal for determining multiple constituents such as moisture, ash, and volatile content
- Achieves streamlined analysis through an automated thermogravimetric analysis batch of up to 19 samples with automatic end point recognition

LECO www.leco.com

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**Biological Analyzer**
**RA816**
**BOOST 2011**
- Designed for biological and clinical research
- Enables rapid collection of detailed information from a range of biological samples, including tissue and biofluids
- Combines the biochemical analysis power of Raman spectroscopy with advanced optical and spectroscopic imaging technologies

Renishaw www.renishaw.com

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**Viscosity Analyzer**
**IVA**
**BOOST 2717**
- Fully-automated, including filling of vials and sample dissolution
- Compatible with typically used organic solvents like decalin, tetralin, tri-chlorobenzene, and ortho-dichlorobenzene
- Dissolution temperature and analysis temperature can be programmed independently from ambient to 200°C

Polymer Char www.polymerchar.com

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**Oxygen Analyzer**
**PeCOD L50**
**BOOST 2856**
- Combines robust performance and flexibility to suit the needs of the user’s laboratory or process operation
- Provides accurate chemical oxygen demand (COD) results in 10 minutes or less
- Highly adaptable for wastewater and drinking water applications

MANTECH www.mantech-inc.com

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**Analytical & Micro-Analytical Balances**
**XPR**
**BOOST 2927**
- Designed to free samples from electrostatic charges for exceptional accuracy and right-first-time results
- Built with a strong focus on regulatory compliance
- Support data integrity when connected to LabX laboratory software

Mettler Toledo www.mt.com

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**Raman Spectrometer**
**HyperFlux™ PRO Plus**
**BOOST 1141**
- Features built-in laser, power, and control/safety hardware
- Provides 10x improvement in spectrometer throughput/signal strength and lower laser power operation without sacrificing performance
- High-Throughput Virtual Slit (HTVS™) technology enables improved Raman analysis

Tornado Spectral Systems www.tornado-spectral.com

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**Sample Prep Robot**
**MicroTasker®**
**BOOST 520**
- Features novel and compact design
- Useful for everyday tasks such as reagent mapping, dissolution, sample ID, sorting, and much more
- Includes easy-to-use interface with LIMS compatible data management

Sirius Automation www.siriusautomation.com

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**Automation**
**Multiplexer**
**BOOST 1230**
- Extends application range of the RA-915AM ambient air and process mercury monitor
- Provides automatic determination of Hg concentrations in different sampling points
- Enables sampling from two to 16 points with the length of the sampling line up to 150 m

Lumex Instruments www.lumexinstruments.com
BASIC

Balances
Equinox
BOOTH 2454
- Bring remarkable precision to labs that perform highly detailed testing
- Eight models feature capacities from 120g-510g and .1mg readability; 12 models have capacities from 360g-8,200g and readability of 1mg and 0.01g
- Color touchscreen display provides icon-driven menus and readily accessible applications and functions

Adam Equipment www.adamequipment.com

Ductless Fume Hoods
Endeavour™
BOOTH 3218
- Eliminate the need for costly installation, ductwork, and over-built HVAC systems associated with traditional fume hood use
- All electronics and blowers are post-filter, so they are never exposed to chemicals used in the hood
- Can be installed and used within minutes

AirClean Systems www.aircleansystems.com

Automated Extraction Unit for Oil and Grease
SPE-Express 2.0
BOOTH 2228
- Single-place, modular units have a small footprint and can be linked together to meet sample throughput demands
- Fully enclosed system — No fume hood needed
- Extracts the sample and evaporates the n-Hexane, eliminating the transfer step
- Fluid sensor verifies an empty sample vessel, and runs multiple samples simultaneously on up to three stations

Environmental Express www.envexp.com

Mill
PULVERISETTE 11
BOOTH 3005
- Ideal for fast and gentle comminution and homogenization of moist, oily, and fatty samples, as well as dry, soft, and fibrous ones
- Includes knife blades with up to four cutting edges and up to 56,000 cutting processes per minute
- Features continuous, reverse, and interval modes

FRITSCH GmbH www.fritsch.de

Balances
LG Series
BOOTH 1612
- Offer capacities up to 220 g in analytical, 620 g in milligram, 6,200 g in centigram, and 10,200 g in decigram
- Feature new user-friendly color touchscreen display
- GLP printing is supported

Intelligent Weighing Technology, Inc. www.intelligentwt.com

Freeze Dryer
FreeZone Triad
BOOTH 1419
- Pre-freezes samples, freeze dried on the shelf in in flasks, and stops under vacuum
- Fits in labs with minimal space
- Data collection and storage allow for repeatability of protocols
- All-in-one design makes freeze drying samples easy

Labconco www.labconco.com

Autosampler
Spinsolve
BOOTH 2139
- Fully controlled by Spinsolve software
- Has 20 slots for 5 mm NMR tubes
- Automatically calculates the times when experiments will start and finish, allowing users to optimize workflow for maximum efficiency

Magritek www.magritek.com

Fume Hood
NovaGuard™
BOOTH 3505
- Delivers competitive containment performance and energy efficiency
- Passed standard and modified ASHRAE procedures at face velocities as low as 50 fpm
- Standard features include full view sash for unobstructed view, double chain and sprocket sash counterbalance system, and Type 316 stainless steel exhaust collar

Mott Manufacturing Ltd. www.mott.ca
Control Panels
Metalphoto®
BOOTH 1543
- Ideal for test and measurement equipment due to their durability in harsh environments
- Do not harbor bacteria or corrode after thousands of sterilization cleaning cycles
- Comply with several medical labeling requirements, including AAMI/CDV-1 ST79:2010/A2.06 and the FDA Amendments Act of 2007 for the establishment of Unique Device Identification System

Metalphoto of Cincinnati www.mpofcinci.com

Turbopumps
HiPace 700 H
BOOTH 2129
- High compression especially for light gases
- Ideal for high vacuum and ultra high vacuum applications
- Interval operation offers more than 90% energy savings without loss of performance

Pfeiffer Vacuum www.pfeiffer-vacuum.com

GPC/SEC Instrument
GPC-QC
BOOTH 2717
- Useful for quality control and process control in polyolefin manufacturing lines
- Provides robust and precise molar mass distribution
- Features a fully-automated sample preparation and an analysis free of manual solvent handling throughout the entire process

Polymer Char www.polymerchar.com

Analytical Balances
XSR
BOOTH 2927
- Deliver a robust and reliable performance for everyday weighing tasks
- Automated, easy-to-configure draft shield doors and an intuitive user interface enables efficient weighing
- Allow users to rest their arms while dosing, as well as to dismantle the balance easily for fast and safe cleaning

Mettler Toledo www.mt.com

Fentany Filtered Hood
Latitude™
BOOTH 1316
- Provides law enforcement professionals with another safety tool when handling fentanyl and its analogues
- Designed with rear wall pre-filter and HEPA filtration
- Incorporates the Safe-Zone filtration system that isolates the pre-filter and main HEPA filter during filter change out

Mystaire www.mystaire.com

 Atomic Force Microscope
Park NX12
BOOTH 714
- Provides versatile platform for analytical chemistry and electrochemistry researchers and multi-user facilities
- Offers ease of use in both air and liquid and a solution for pipette-based SPM techniques
- Features Inverted Optical Microscope (IOM) based platform for SICM, SECM, and SECCM

Park Systems www.parksystems.com

Homogenizer
Multi-Prep
BOOTH 1129
- Can homogenize up to six samples in five-50ml tubes with optional oscillations for greater sample breakdown
- Saves time and provides enhanced sample breakdown and repeatability with more consistent results
- Automatically self-engages and disengages its specially designed probes after homogenization

PRO Scientific Inc. www.proscientific.com
Portable Viscometer
**PDV-4.5**
**BOOTH 2218**
- Reduces testing time because sample tube cleaning is not required
- Consists of a main body with a disposable (or reusable) syringe and a falling needle attached to an extension bar with two markings
- Conforms to SAE AIR 5704 and ASTM D5478

Stony Brook Scientific Ltd. [www.stonybrooksci.com](http://www.stonybrooksci.com)

**INFORMATICS**

LCD Controller
**ECO**
**BOOTH 2015**
- Allows for up to nine programs along with USB and Ethernet communication
- Replaces two controllers on all of the company’s dry-heat ovens, incubators, and stability chambers
- Features real-time programming and cycling

BMT USA [www.bmtusa.com](http://www.bmtusa.com)

**Pumps**
**Masterflex®**
**BOOTH 2229**
- Meet 21 CFR Part 11 and EU Annex 11
- Provides pump operators with the ability to remotely control and monitor pumps via the Internet without the need to be onsite.
- When enhanced security, data control, and electronic records are critical, companies can meet 21 CFR Part 11 and EU Annex 11 compliance with a low-cost subscription service.

Cole-Parmer [www.coleparmer.com/Masterflex](http://www.coleparmer.com/Masterflex)

**Chromatography Software**
**Clarity**
**BOOTH 2136**
- Enables control of 700+ different instruments from one environment
- Includes six languages — English, Chinese, Russian, Spanish, French, and German
- Brings easy operation, unmatched free user support, and optional extensions that support a variety of applications

DataApex [www.dataapex.com](http://www.dataapex.com)

**LIMS**
**LabVantage 8.4**
**BOOTH 2935**
- Encompasses LIMS, ELN, and LES
- Includes updates around data privacy, master data management, customer specifications, bulk data import, automated issue tracking, and more
- Allows managers to see both current and upcoming work, and assign it to individuals or groups of users

LabVantage Solutions [www.labvantage.com](http://www.labvantage.com)

**Chromatography Software**
**DryLab**
**BOOTH 3201**
- Reliably predict the movements of peaks, selectivity changes, and retention times of any multidimensional design space
- Provides the insight and scientific understanding of the chromatography behind your method
- The Robustness module has been added to further instrument parameters

MOLNÁR-INSTITUTE [www.molnar-institute.com](http://www.molnar-institute.com)

**LIFE SCIENCE**

**Extraction System**
**DBS-MS 500**
**BOOTH 2234**
- Fully automated device uses state of the art technology to analyze Dried Blood Spots (DBS)
- Reports run parameters, analysis results, and pictures of each DBS card (before and after extraction)
- Offers strong advantages compared to both manual and semi-automated punching techniques

CAMAG Scientific, Inc. [www.camagusa.com](http://www.camagusa.com)

**Electron Microscope**
**FlexSEM 1000 II**
**BOOTH 4001**
- Redesigned for better performance and improved ergonomics
- Delivers full-sized SEM performance in a compact and easy-to-use footprint
- Comes standard with variable-pressure mode, SE and BSE detectors, chamber camera and camera navigation, and more

**CO₂ Incubators**

**In-VitroCell ES**  
**BOOTH 2246**

- Come with “Plug and Play” feature, which allows the user to simply plug in the incubator once delivered and begin using
- Preconfiguration allows for a hassle-free installation
- Provide accurate and precise control of humidity, temperature, CO₂, and sterility

NuAire  
www.nuaire.com

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**SWIR Camera**

**Ninox Ultra**  
**BOOTH 1958**

- Offers ultra-low dark current for longer exposures of up to five minutes
- Runs at 100Hz in full resolution through a CameraLink interface
- Provides high intrascene dynamic range of 70dB, enabling simultaneous capture of bright and dark portions of a scene

Raptor Photonics  
www.raptor photonics.com

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**SUPPLIES**

**Quartz Spacers**

**C8121, C8122**  
**BOOTH 1349**

- Suitable for Gerhardt®, FIBREThERM®, and FibreBag® systems, which are used for fiber analysis in animal feeds and similar products
- C8121 includes six quartz spacers for use in the FibreBags®, while C8122 is a pack of six quartz crucibles for use in the incineration module
- C8121 includes upgrades to avoid the commonly reported issue of deformation and short life

EA Consumables, Inc.  
www.EAConsumables.com

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**RFID Bottles**

**BOOTH 2228**

- Allow users to track samples from collection to analysis; chain of custody for audits to prove samples have been collected to specific parameters according to testing method
- Each individual container has a unique ID number
- Count inventory without having to open a single box; RFID tags available on cartons

Environmental Express  
www.envexp.com

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**High Pressure Pump**

**NRD-08Z**  
**BOOTH 506**

- Suitable for laboratory water filtration systems and other OEM circulation systems found in biochemical analysis and thermal management devices
- Utilizes robust 24V BLDC canned motor technology to provide a compact, quiet, low vibration
- Liquid temperatures range from 0-50°C (32-122°F) and ambient temperatures range from 0-40°C (32-104°F)

Iwaki America  
www.iwaki custompumps.com

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**Membrane Filters**

**Track-etch**  
**BOOTH 3100**

- Polycarbonate and Polyester membranes offer controlled pores sizes and a smooth, glass-like surface
- Ideal for use in microscopy, cell culture, microfluidics, and liposome extrusion
- Transparent, hydrophilic, hydrophobic, and dyed membrane options are available to suit unique applications

Sterlitech Corporation  
www.sterlitech.com

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**Foam Swabs**

**BOOTH 831**

- Replace cotton swabs when cleanliness is critical
- Wide range of sizes and shapes make lab equipment maintenance and cleaning quick and efficient
- Available in pre-saturated or sterile formats

Super Brush LLC  
www.superbrush.com

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**Monolithic Column**

**BOOTH 628**

- Can operate under high flow rate with minimal increase in the operating back pressure
- Exhibits high connectivity and the precisely controlled pore size (0.5 um-2 um) especially suits purification of small to large biomolecules
- Improves throughput performance and shortens running time

Tantti Laboratory Inc.  
www.tantti.com
PREVENTING INSTRUMENT MAINTENANCE ISSUES AND DOWNTIME

Problem: Unplanned and unexpected instrument downtime in a lab means delays and frustrations that can potentially damage a lab’s reputation to reliably deliver high-quality results. A 2018 survey of 700 lab managers in four countries—conducted by market research firm Frost & Sullivan on behalf of Agilent Technologies—asked lab managers to rank their top five challenges. Instrument maintenance and downtime topped the list at 73 percent.

Regular instrument maintenance is essential for sustaining high instrument performance and minimizing costly unplanned downtime. But many variables, including high sample loads, multiple work shifts, and challenging operating conditions can drive the need for more frequent maintenance than just the basic manufacturer recommended intervals. Keeping track of all that can be a chore, especially when there are multiple instruments in the lab.

Solution: Agilent CrossLab Smart Alerts can help prevent the headache of GC instrument downtime. Smart Alerts is data-driven instrument maintenance software that monitors actual instrument usage, and provides timely recommendations based on long-term evaluation of instruments under different operating conditions. Smart Alerts can be loaded onto any PC in the lab, and then collects information known as Early Maintenance Feedback (EMF) from instruments across the lab. This data is compared against recommended application-specific limits. When an EMF limit is reached, an email is sent with a recommended action. The lab manager then decides what to do next. This may be replacing a consumable or performing or requesting preventative maintenance on the instrument. Active alerts are conveniently consolidated into a single email for connected instruments. Smart Alerts also provides “upcoming” alerts, so there is time to plan for instrument maintenance at a time that is convenient to lab operations. Incorporating a user-friendly interface, making expanded use of sensors and connectivity, and accessing real-time usage and performance data, the Smart Alerts dashboard provides a view of all instruments across the lab. This enables operators to monitor instrument status between email alerts and track active alerts independent of email. Lab managers can further customize Smart Alerts by adjusting EMF limits based on their own experience and expectations.

Staying ahead of the game with data-driven decisions is an important evolution of any lab’s workflow efficiency and diagnostics strategy. Smart Alerts can help a lab become a truly “smart connected lab.”

For more information, please visit www.agilent.com/crosslab-smart-alerts
Equinox Touchscreen Balances

Offering superb precision, Equinox is our most advanced line of balances. The Equinox series features semi-micro, analytical and precision models with capacities up to 8200g. The balances feature readabilities of 0.01mg, 1mg, and 0.01g.

PACKED WITH TIME-SAVING APPLICATIONS
Equinox features nine built-in applications to save time for busy lab workers.
• Weighing
• Parts counting
• Percentage weighing
• Checkweighing
• Dynamic / animal weighing
• Accumulation
• Density determination
• Display hold
• Formulation
• Statistics
• Textile

CONNECT TO YOUR NETWORK
All Equinox models feature an RS-232 interface, and a USB port accommodates a memory card to save results. Printouts provided by the balance include date and time, essential for traceability and data tracking within Good Laboratory Practice guidelines. You can also print out calibration data for traceability.

RESPONSIVE TOUCHSCREEN
A color touchscreen display provides intuitive operation, with icon-driven menus and readily accessible applications and functions. The five-inch screen offers 800 x 480 pixel resolution for excellent visibility.

ADVANCED SECURITY
Password control prevents unauthorized access to the balance, ensuring settings remain unchanged.

www.adamequipment.com/equinox-analytical-balances
Q

Is there a product out there that would help me work safely with fumes that wouldn’t require a hook-up to exhaust ventilation?

The work I’m doing in my lab requires the use of a snorkel, but I don’t have the access to exhaust ventilation in my space and a lab renovation is out of the question.

A

Yes, you can use a filtered downdraft table.

When you’re working on something that would normally require the use of a snorkel but you don’t have access to one, you can use this work station. By using negative air pressure, noxious fumes, solvents, acids, particulates, and powders are pulled away from the user toward the back of the downdraft table and through a specialized filtration and detection system. It scrubs the air and then recirculates clean air back into the lab. The advanced filtration, which resides below the table, eliminates the need to connect to exhaust ventilation. All you need is access to a power outlet and you’re ready to work!

Also, recirculating the air has a hidden benefit of saving money over time. With products that require a traditional exhaust ventilation system, the conditioned air of the lab is constantly lost and the HVAC system is continuously working to heat/cool the lab environment—this is very costly! Eliminate this extra expense when using a filtered work station.
WIN a VIAFLO 96/384 to supercharge your microplate pipetting!

Pipetting from plates or reservoirs to plates with a standard single- or multichannel pipette can be tedious and error prone. It requires high levels of concentration to avoid double dosing or skipping wells and ensure consistent volume transfers, limiting throughput. Previously, the only way to overcome this issue was to invest in fully automated liquid handling robots. These robots are expensive and complex to operate, putting them out of reach for many labs. If that sounds like a familiar story, then the VIAFLO 96/384 could be the answer for your lab. Offering straightforward liquid transfers for 24-, 96- or 384-channel in parallel, the VIAFLO 96/384 offers labs an affordable, compact and user-friendly solution to increase productivity. The unique operating concept makes VIAFLO 96/384 as easy to use as any traditional handheld pipette, eliminating the need for robotics expertise.

VIAFLO 96/384 HIGHLIGHTS INCLUDE:

• One-handed operation, leaving the other hand free to handle labware
• Simultaneous pipetting for every well of a microplate
• Easily interchangeable pipetting heads, allowing you to switch between 24-, 96- and 384-channel pipetting to suit your application
• GripTip pipette tips that never leak or fall off
• Intuitive Touch Wheel interface for a quick and ergonomic way to modify pipetting parameters
• A choice of 10 preset pipetting programs for common liquid handling tasks, plus up to 40 user-defined protocols

The VIAFLO 96/384 turns plate replication, plate reformatting or reservoir-to-plate transfers into a single pipetting operation, speeding up your workflows. We want everyone to have the chance to experience this for themselves, so we’re giving away a VIAFLO 96/384, complete with a starter pack of matching pipette tips and reagent reservoirs. All you have to do is fill out a short questionnaire that will help us to understand your pipetting needs even better. And even if you don’t win a VIAFLO 96/384, you could be one of 50 entrants to receive a $20 Amazon voucher. The deadline for entries is the 31st of March 2019, and the winner will be announced shortly afterwards.
Millipore Sigma, a business of Merck KGaA, Darmstadt, Germany, has completely redesigned its flagship Milli-Q® product, launching the new Milli-Q® IQ 7003/7005 ultrapure and pure lab water system. Now more easy to use, compact, and sustainable, this fully-integrated system delivers consistently superior quality Type 1 and Type 2 water directly from tap water. The Milli-Q® IQ 7003/7005 water purification system is designed to exceed researchers’ most demanding expectations – from improved productivity to reduced environmental impact.

**Milli-Q® IQ 7003/7005 system**

MilliporeSigma has created a new, intelligent storage solution that protects the quality of stored water better than ever before. Unique design features include system auto-rinsing prior to production to ensure only highest quality pure water enters the tank; a seamlessly integrated vent filter for improved protection against airborne contaminants; a built-in ech2o™ bactericidal UVC LED lamp; and automatic recirculation of stored water through the purification loop preserves water quality in the tank. This new storage solution ensures that highest-quality Elix® water is always on hand and ready to use.

Following in the footsteps of the Milli-Q® IQ 7000 ultrapure system with its ergonomic Q-POD® ultrapure water dispenser, the Milli-Q® IQ 7003/7005 ultrapure and pure system boasts a similarly redesigned E-POD® pressurized pure water dispenser. The system can support up to 4 PODs (1 E-POD® and 3 Q-POD® units, or 4 Q-POD® units), all of which contain integrated digital touchscreens that allow intuitive system operation, convenient water dispensing, and rapid data access.
Available in capacities up to 8,200g, Solis semi-micro, analytical and precision balances are an outstanding choice for complex lab weighing tasks. A high-resolution graphic display offers intuitive operation, while the keypad features easy-to-read buttons and helpful navigation arrows. Solis stores up to 99 ingredients for speedy recall.
It is a well-known fact that women account for a minority of the world’s researchers. But those who overcome the obstacles and succeed in their scientific fields may come up short when it comes to their leadership skills. Our March issue will examine what some organizations are doing to help women become strong leaders in the scientific workplace.

1 Centrifuge Resource Guide
An essential piece of basic laboratory equipment, the centrifuge applies thousands of gravitational force equivalents to a sample while spinning in order to separate structures and particles suspended in a liquid. Although centrifugation theory is straightforward, its engineering literature is voluminous due to the number of industries and research operations that depend on the operation.

Read more at LabManager.com/centrifuge-guide

2 Trending on Social Media: Get the Red Out
As of Jan. 4, Lab Manager’s top December issue article posted to social media was our Industry Insights article discussing the potential health risks associated with red food dyes. A number of food safety incidents caused by the illegal addition of inedible dyes have been reported across the globe in recent decades, prompting increased attention toward regulations that control how foods can be colored.

Read more at LabManager.com/food-dyes

3 Most Popular Webinar
Our most recent top webinar on LabManager.com with 276 registrants was “Ergonomics for the Lab and Office.” This Safety First webinar taught participants how to recognize the most common risk factors and how to mitigate them. Proper set up for common lab tasks and computer workstations was also presented. Though it ran on Dec. 5, you can still register to watch on-demand.

Read more at LabManager.com/ergonomics

We look back at our web content since the December issue and look forward to what’s in store for the upcoming March 2019 issue.

NEXT ISSUE ➔ Women in Science
It is a well-known fact that women account for a minority of the world’s researchers. But those who overcome the obstacles and succeed in their scientific fields may come up short when it comes to their leadership skills. Our March issue will examine what some organizations are doing to help women become strong leaders in the scientific workplace.
Dear Linda,

As the recently promoted manager of my lab, I am tasked with setting up and facilitating weekly staff meetings. My predecessor had a very casual style when it came to running meetings, which I found less than productive and sometimes confusing. The biggest problem was not having an agenda ahead of the meeting. Afterwards, other staff and myself were not clear on who was suppose to do what and when. I would like to change that style going forward to create more efficient and productive meetings. Any tips?

Thanks,
Lydia

Dear Lydia,

Managing meetings isn’t easy. However, it is a skill that can be learned. The following guidelines can help:

**Publish and follow an agenda**
The easiest way to get a meeting off to a productive start is to include timeframes for each agenda item. That way you can specify who needs to be at each part of the meeting. Nothing frustrates busy professionals more than sitting through parts of a meeting that do not concern them.

**Start on time**
Scientists often have interruptions and schedule changes that are beyond their control. Starting on time can be tough, but every attempt should be made to stay on the established schedule.

**Give periodic summaries**
During the meeting, occasionally review what has been covered by asking group members to summarize the discussion up to that point.

**Assign tasks to participants**
Good meeting managers often assign different tasks to group members. Usually these are formal assignments that take advantage of the participants’ natural skills and abilities.

**Ask questions**
Ask questions that cannot be answered with just a yes or no. When you ask for someone’s opinion, listen carefully and acknowledge that you heard and understood what was said.

**Debrief**
The last item on your agenda should always be team analysis and group self-assessment. Even if you must call someone or ask a couple of questions as you walk down the hall, get a sense of how the meeting was perceived by one or two of the participants.

If you try some of these techniques, you may walk out of your next meeting thinking, “Hey, that went really well!”

Cheers,
Linda

**Have a question for Linda?**
**Email her at:** Linda@labmanager.com

**For more info:** labmanager.com/meeting-basics
THE PHOENIX SERIES
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GENOME
DNA Sequencing, PCR, Electrophoresis

BIOCHEM
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CITATION
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