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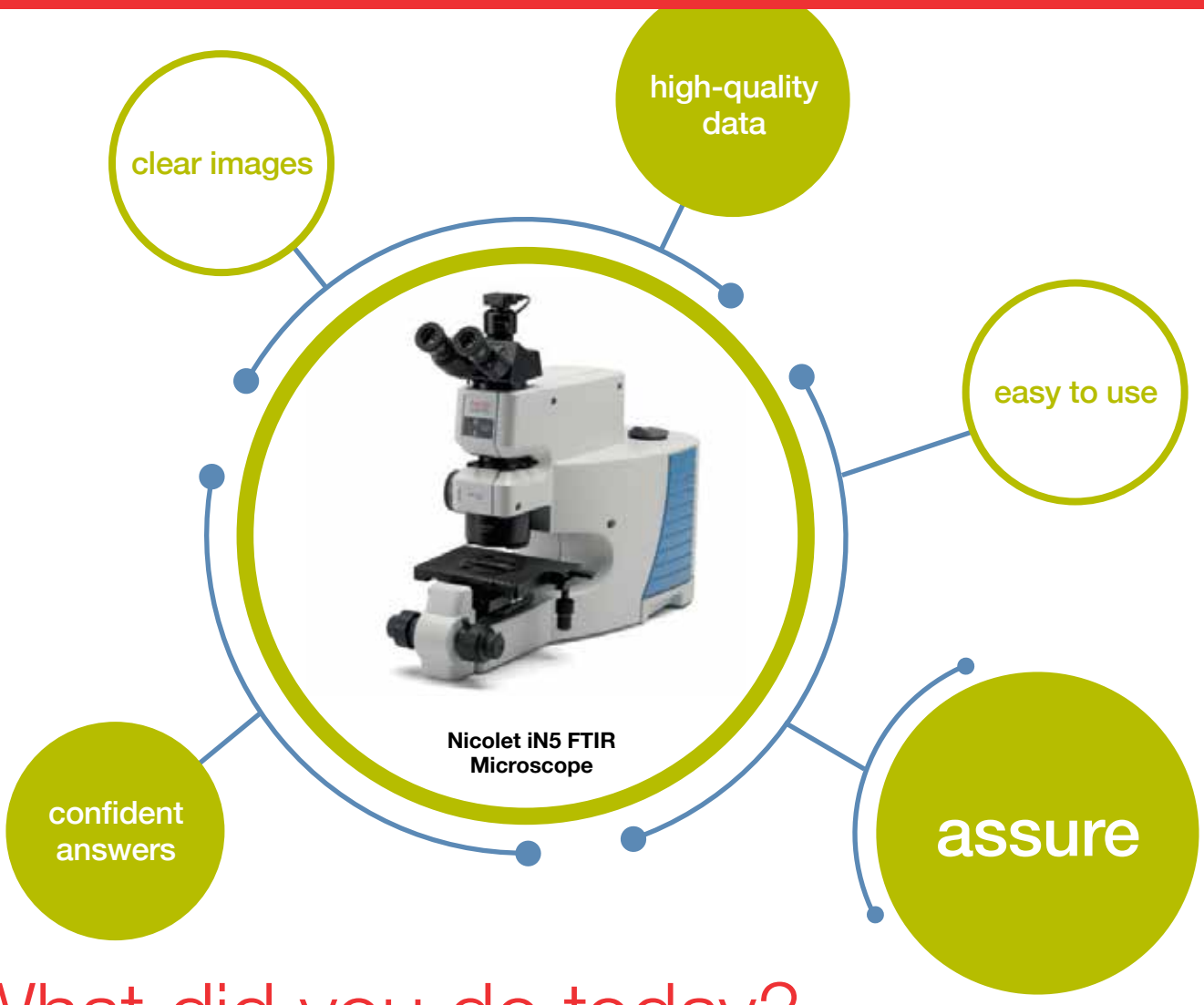

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political science

Once upon a time a working scientist's task was to focus on a singular research challenge—usually supported by government or institutional funding—conducted well outside the sphere of politics, business, finance, or marketing. But this month's issue paints a very different picture of what today's researcher needs to be concerned with.

"As the funding landscape changes, so do the ways scientists do business," Key Kidder tells us in this month's cover story, which looks at the political machinery behind federal R&D funding under the current administration. Decisions from the White House that are unfavorable to the scientific community have also prompted greater political and social engagement. "Some scientists are doing the groundwork to develop a deeper bench of congressional champions, the better to influence legislation and make policy," says Kidder. This "new normal" will most likely continue to teeter the lofty perch scientists once enjoyed.

In this month's Labs Less Ordinary (page 14), author Rachel Muenz looks at a scientific enterprise with both business and ecological implications. Relying on government funding from two separate entities, a research team from the University of New England set up a "lab" at the floating Bangs Island Mussels farm in Casco Bay, Maine to learn more about how aquaculture impacts ocean ecology. "As the industry in the United States matures more and more, we'll need more people with science backgrounds to keep our aquaculture industry moving forward," says mussel farm owner Matthew Moretti.

Last month we introduced the idea of crowdfunding as an alternative route for financing scientific research. This month, in Part II, we look deeper into the requirements for crowdfunding success which, unlike traditional grant writing, has everything to do with marketing and communication. "A lot of the things that make projects successful are not necessarily the project itself. It's often the scientist's ability to communicate what they're doing and reach people and be really proactive—so, marketing, essentially," says Natalie Jonk, founder of the UK-based crowdfunding site Crowd.Science. Turn to page 18 to learn more.

As most lab managers know, the job of finding and retaining the right people for their lab is a challenge. Once upon a time when talent pools were smaller and local and the job to be filled was straightforward, hiring was easier. In this month's "Sourcing Top Talent" article (page 26), author Donna Kridelbaugh talks to a number of recruitment pros. Besides recommending that managers outsource their talent search projects, they also remind readers of the importance of promoting their company's or institution's image—particularly for millennials. "Companies are taking a new and fresh look at their image to ensure they are attractive to millennials and will be perceived as an employer of choice," says John Pender, global program director with Korn Ferry Futurestep.

Two articles this month look at the problem of experiment reproducibility/repeatability. "The Repeatability Issue" (page 34) and our Product Focus article on PCR (page 54) both look at technologies for addressing repeatability: intelligent sensors, data visualization, and remote access in the first case, and the analysis of short tandem repeats (STRs) for human cell line authentication in the second.

From understanding the politics of federal research funding, to developing proactive marketing skills for do-it-yourself funding, to marketing your company or facility to attract a new generation of researchers, it's clear that managing a lab these days is far from what it once was. I trust you're up for the challenge.

Best,
Pam

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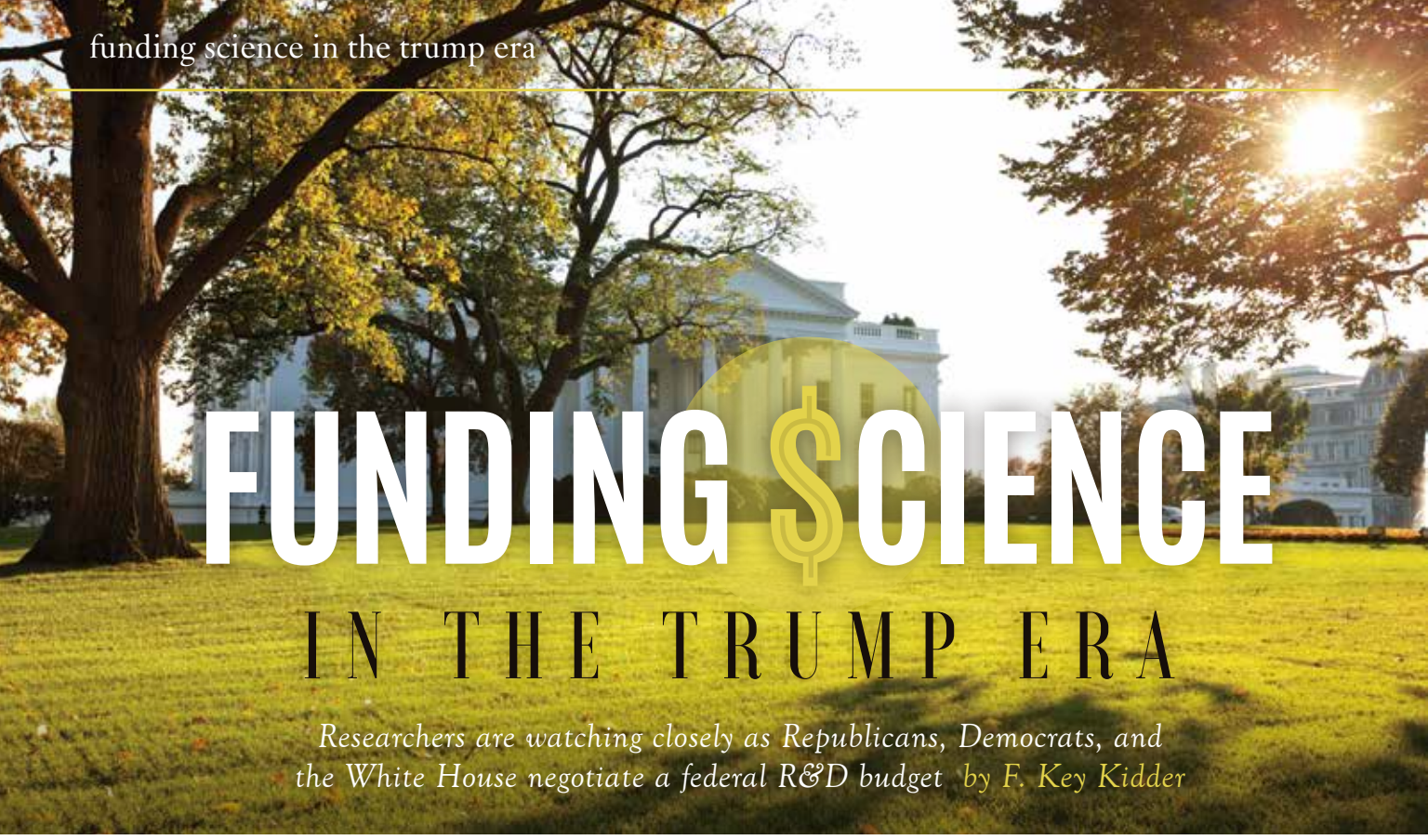


FUNDING $CIENCE IN THE TRUMP ERA

Researchers are watching closely as Republicans, Democrats, and the White House negotiate a federal R&D budget by F. Key Kidder

Who will step up to help Andrew Lamar Alexander, Jr., stop the bleeding?

The senior U.S. senator from his native Tennessee, Alexander is a consummate political professional and champion for science, an uncommon skill set among members of the 115th Congress.

Elected in 2003, Alexander has accrued enough seniority to acquire real power. Washington, D.C., is a town that corners the market on self-important people, but even they know to make way for appropriations subcommittee chairmen who control the purse. Inside the Beltway they're called cardinals, as godlike as the College of Cardinals who select the pope.

As chairman of the Senate Appropriations Subcommittee on Energy and Water Development, Alexander presides over the decision process that dispenses federal funding to a multitude of research-intensive entities within his subcommittee's oversight, including Tennessee's very own Oak Ridge National Laboratory.

A crown jewel of America's national research enterprise, Oak Ridge is home to scientists conducting cutting-edge basic research that leads to serendipitous discoveries, which have included the laser, global positioning navigation systems, and magnetic resonance imaging (MRI) machines.

Researchers write grant proposals hoping to use unique research tools housed at Oak Ridge, including the Spallation Neutron Source, a particle accelerator that is the most powerful of its kind in the U.S. And in early 2018, an IBM supercomputer acclaimed the world's fastest is scheduled to be up and running at Oak Ridge, bringing home bragging rights held by China.

That sort of news should delight an ardent nationalist like President Donald Trump, but it didn't stop his administration from putting Oak Ridge research programs on the chopping block when the president's budget was released in March.

Research investments

Alexander countered by hurrying a bill through his subcommittee to restore funding to the U.S. Department of Energy's Office of Science. The DOE is among America's largest employers of scientists and engineers, many working in national labs. Under Trump's budget, some 1,600 positions at Oak Ridge were targeted for elimination.

Earlier, Alexander was at the forefront of a bipartisan congressional show of force that rejected Trump's fiscal year 2017 science cuts, last-minute changes he wanted written into an omnibus spending bill before he became president.

Lawmakers from both parties always try to protect federal dollars flowing into their states, but some of Trump's cuts were egregious nonstarters for members who support "research investments," as R&D spending is often called on the Hill, reflecting the generally high regard in which legislators hold it.

The battle lines are drawn. Congress has the power of the purse—authority over spending and taxing—and most of its members share the widely held belief that scientific R&D benefits society and drives economic development.

But besides the enormous power of the presidency at his disposal, Trump has the presumptive support of the majority party in both the House and Senate, a long memory for those who displease him, and a propensity for doubling down instead of compromising.

If a man of Alexander's stature can't hold the line and protect his prestigious pet projects like Oak Ridge, is anything safe?

Evisceration

Trump rode into the Oval Office on his promise to "drain the swamp" of bad deals for taxpayers and to reduce government sprawl. Then there's the little matter of reducing the national debt. And should he persuade Congress to lower taxes, as promised, even deeper cuts will be in order.

Disparaged as the most anti-science president ever before his inauguration, Trump didn't disappoint. The magnitude of his proposed cuts to federally funded science and research operations exceeded the worst expectations of many.

Critics compared "America First: A Budget Blueprint to Make America Great Again" to an evisceration. The National Institutes of Health budget was cut 20 percent, the Environmental Protection Agency was whacked with a 50 percent reduction, and on and on. Ramifications extend beyond the agencies themselves. More than 80 percent of the NIH budget is spent supporting some 300,000 outside researchers, and EPA cuts, broadly speaking, might leave the job of safeguarding America's air and water to local officials.

Trump's defenders say that some federal investments in R&D have been duplicative or ineffective, while others ought to be handled by the private sector. And there's still $150 billion in R&D funding on the table in FY2018.

Another argument for spending less on innovation is that America simply cannot afford to spend more. And besides, as Trump's $1.1 trillion budget reflects, there's a new set of priorities in D.C.: the Pentagon and the Departments of Homeland Security and Veterans Affairs.

New normal

Federal R&D spending as a percentage of America's GDP has been declining for decades. Now it's reached the point where the federal purse no longer funds the lion's share of basic research.

As the funding landscape changes, so do the ways scientists do business. When federal funding flattened, corporate and private money picked up the slack to become the dominant funders. Academic researchers would seem to have the most to lose under this new arrangement, but college administrators hope to persuade the White House to ante up for research to keep pace with China's investment level.

> "Under Trump's budget, some 1,600 positions at Oak Ridge were targeted for elimination."

Science has traditionally enjoyed bipartisan support from appropriators on the Hill, but Trump has emboldened diehard conservatives. As Alexander tries to restore cuts on the Senate side, Lamar Smith (R-TN) keeps cutting on the House side, stripping away funding support from social sciences and climate and energy research. Chairman of the House Science, Space and Technology Committee, Smith takes credit as the first member of Congress to donate to Trump's presidential campaign.

Baby boomers will drive increased demand for health/medical services and innovative treatments but further strain hungry entitlement programs that consume larger slices of the budgetary pie.

Throw in some of Trump's other proposals for the fiscal year—extended caps on nondefense spending and a big bump up for the Pentagon—and there's little to suggest the final budget will deviate from a trajectory constricting federal discretionary spending. For the foreseeable future, legislative favorites like research investments will be closely scrutinized. Invariably, scientists face a new normal of less federal funding and increased competition for grants and support.

Politicized

Science remains apolitical, but now some scientists are becoming politicized—rising up to make themselves heard in protest, joining marches, organizing politically, forming political action committees, and strategizing to win elected public office.

It's the Trump Effect, a political jump start that represents another giant step forward toward public engagement and intermingling, and a remarkable turn of events for a profession that largely practiced under the radar and avoided engagement until very recently, now gingerly climbing aboard the Internet/social media bandwagon.

Newly energized, scientists took to the streets of Washington, D.C., last April for the March on Science. Some sat it out, concerned that science would be lumped with sundry liberal social causes into an amorphous anti-Trump protest. Some marched in solidarity, some because they had simply had enough.

For that matter, the president and most scientists appear to have very little in common. Last time anyone checked, in 2009, just six percent of scientists identified as Republican. (Fifty-five percent were Democrats, 32 percent independent, and the rest "don't know.") Does Trump know that most federal funding is awarded to scientists working on America's East and West Coasts, both reliable Democratic strongholds that voted for Hillary?

Scientists aspiring to higher office must contend with an electorate separated by a growing partisan divide over how much government should spend on scientific research, according to a Pew Research Center study conducted in April 2017. Among Democrats and those leaning Democrat, 60 percent would increase spending. Among Republicans and those leaning Republican, 33 percent would. In 2001, the divide was miniscule.

Instead of leaning on a few heavy hitters like the methodical, disciplined Alexander, some scientists are doing the groundwork to develop a deeper bench of congressional champions, the better to influence legislation and make policy. According to the Congressional Research Service, Rep. Bill Foster (D-IL) is the only current member with a doctorate in a scientific field. The two professions are worlds apart in the public eye—scientists generally esteemed, politicians scorned. Science is progress, politics darkly partisan.

Back to work

The different budgets in play are opening moves in what shapes up as complex, contentious negotiations between Republicans, Democrats, and the White House to reconcile all three versions—the presidential budget and the House and Senate proposals.

Budget battles are grueling, but political observers say this one is already ripe. It's always hunting season for both parties on the Hill now, with the atmosphere far too poisonous for Democrats and Republicans to agree on anything of substance without requisite extensive quarreling.

The treatment the president's budget receives from appropriators depends on how events unfold after Congress returns from its August recess and gets back to work.

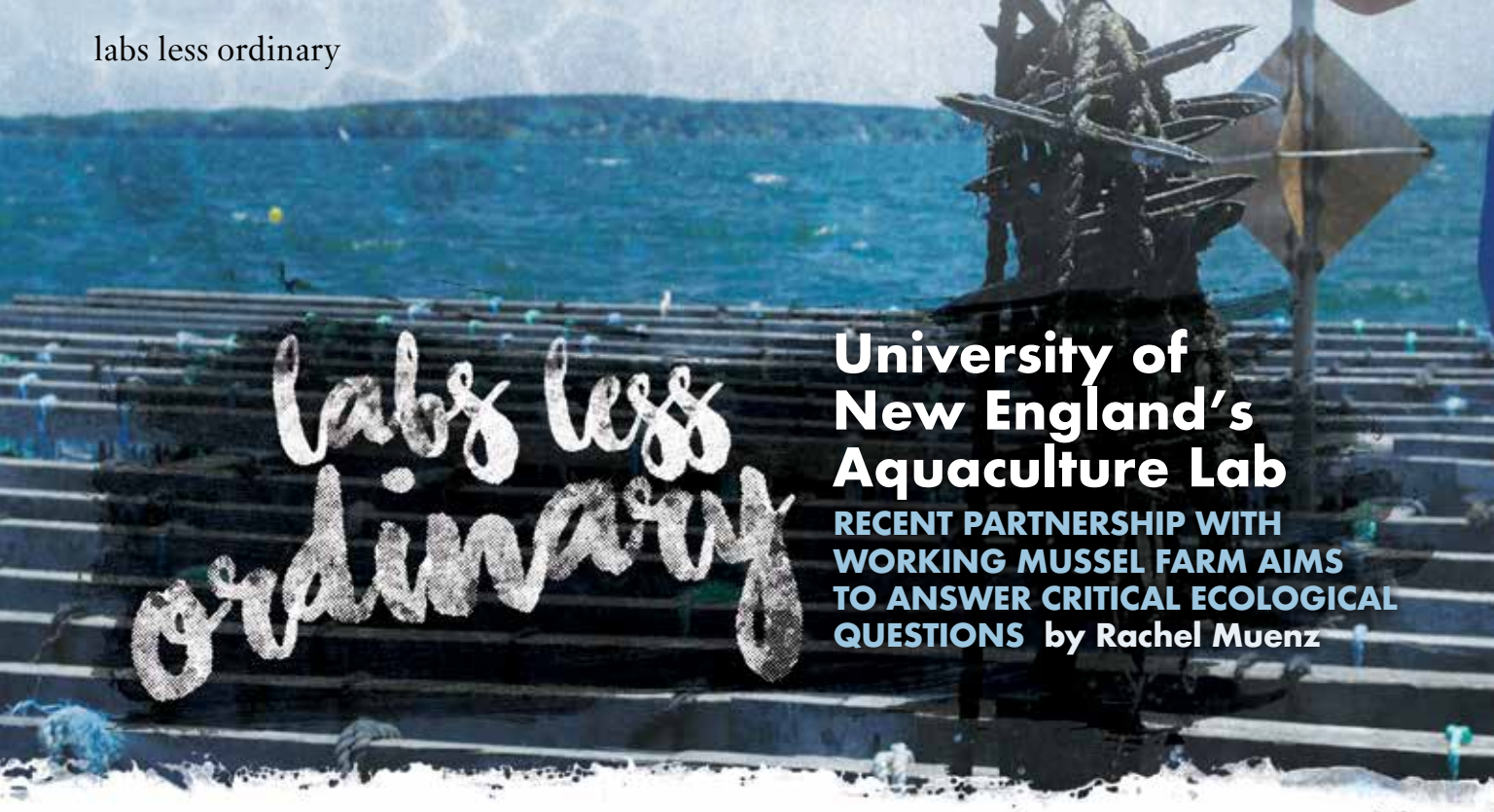
Democrats have budget issues across the board and can exercise their filibuster power. Republicans will oppose such steep cuts, and many will protect science.

Biomedical science seems safe because everyone wants cures for disease. Pharmaceuticals continue to drive an increase in corporate basic research, and the industry has a track record of attracting streams of financial support from private-sector sources.

The wild card is a mercurial, combative president. Should budget negotiations drag on, Congress can approve continuing resolutions, temporary spending measures that fund agencies at current levels. Or come September, at the end of the fiscal year, the president might ramp up his war against Washington elites and sprawl and decide America's capital city needs a good government shutdown.

A president who prizes the winners will take some losses before the budget is finalized. On the Hill, science matters. Now the trick is to send in the reinforcements to make science matter even more.

F. Key Kidder *left journalism to pursue a career in government relations, politics, and PR, but he still likes to keep his hand in writing. He can be reached at k2@keykidder.com or 410-963-4426.*



University of New England's Aquaculture Lab

RECENT PARTNERSHIP WITH WORKING MUSSEL FARM AIMS TO ANSWER CRITICAL ECOLOGICAL QUESTIONS

by Rachel Muenz

Last summer, it became clear to Matthew Moretti that his mussel farm could use more scientific expertise when a percentage of his mussels died on the line—a so-called mortality event.

"We had a lot of theories [about the cause], but we didn't really know exactly what happened," says Moretti, who owns Bangs Island Mussels with his father, Gary, through their company, Wild Ocean Aquaculture, LLC (Portland, ME). "Our science component was lagging behind. We knew that we could grow mussels and kelp well, but we didn't have a lot of the technical knowledge that we should have had to be able to really monitor what was going on."

So he reached out to University of New England (UNE) assistant research scientist Adam St. Gelais and assistant professor Carrie Byron. After some preliminary discussions and tests on a sample of Moretti's blue mussels, St. Gelais asked if he'd be interested in doing a larger study to determine how factors in the environment are affecting his mussels. Moretti jumped at the chance, helping write a grant proposal for the Northeast Sustainable Agriculture Research and Education program, which will fund St. Gelais's histology part of the project for the next two years. In addition, an Established Program to Stimulate Competitive Research grant allowed them to set up Moretti's farm as a lab this summer as part of the Sustainable Ecological Aquaculture Network (SEANET). That funding allowed the team to purchase probes, sensors, data loggers, and handheld instruments to monitor the various rafts where Moretti grows his mussels on two sites in Casco Bay, Maine.

▲ Rope used to grow blue mussels (*Mytilis edulis*). This rope is dropped vertically in the water column to collect and grow mussels.

While there are other such research-intensive farms in the SEANET project, Byron says that the 3.66-acre Bangs Island Mussels farm, in her opinion, is "the most equipped with scientific instruments" and "more like a lab than any of the others."

Both Moretti and the researchers see the partnership as a great opportunity to learn more about how aquaculture impacts ocean ecology.

"We know that what we do is good for the environment," Moretti says. "Shellfish farming and seaweed farming are good for our local ecosystem, but this will give us a really cool view into more specific ways that we impact our surrounding waters."

Byron's group is interested in how a farm in the coastal environment influences food web dynamics—how energy is moving through the food web and predator-prey relationships, along with how the food web promotes the production of more mussels.

Specifically, she's looking at how mussels' fatty acid content—important in humans' diet because our bodies can't make fatty acids on their own—is affected by the mussels' own diets, the amount of stress they're under, and other environmental factors.

"We're looking very closely at what the mussels themselves are eating or what's available for them to eat in the water," Byron says, adding that they are also exploring the mussels' tissue quality and growth rates.

The sensors and other equipment deployed on the ropes suspended from the 40 × 40–foot rafts where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Moretti grows his mussels allow the group to record real-time temperature, salinity, dissolved oxygen, and some indicators that will allow them to understand the water's pH level. That information will ensure that, in the future, they'll know exactly which factors may be affecting the mussels' health, other creatures that live on the farm, and their environment. While the partnership is still new and they've only just started gathering data, it has a lot of potential benefits.

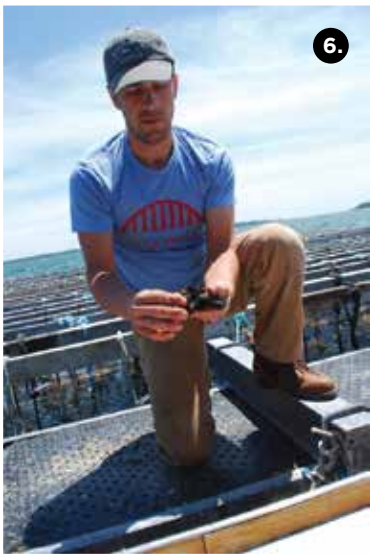
"This information will definitely help us understand what's happening on our sites, but it will also help us plan for the future better," Moretti says. "If we're seeing changing characteristics in the water, we can perhaps develop some strategies to mitigate those changes or overcome those changes." The data will also help them identify new sites to expand the farm to in the future.

For St. Gelais, Moretti's farm is the perfect setup for different scales of experiments. Because the rafts are all identical and there are two different sites, one close to shore and one farther away, "the farm itself is sort of already set up in replicate, which makes it a very interesting and fun place to design experiments around," he says. That layout allows them to ask about how the health and condition of the mussels vary, both from raft to raft as well as between the two different sites.

Twice a month, the farm's crew helps gather a random sample of 15 mussels from each site, which are brought back to UNE. Five mussels are prepared for histology, five for fatty-acid analysis, and five for stable isotope testing. In addition, the researchers go out in their own vessel to Moretti's near-shore site and sample 15 mussels from each of the rafts to better understand the differences between those mussels.

As far as challenges, Moretti says there haven't been any on his side because of the extensive planning and meetings between the two groups, but there are a few issues the researchers have run into.

"Managing a lab in a building is hard enough, and then trying to manage one that's floating in the ocean that you don't have total control over is always difficult," St. Gelais says, adding that access to the site can sometimes be a



1. Connor Jones, UNE master's student, holds a bag of market-sized mussels collected from growing ropes on Matt Moretti's farm.

2. Carissa Maurin, UNE master's student, sits on Moretti's farm floats while collecting samples.

3. Juvenile mussels pulled from growing ropes. (Sub market size).

4. Sign board on floating work platform at Moretti's farm site.

5. Research vessel next to Moretti's farm.

6. Matt Moretti shows a few juvenile mussels from his ropes.

All photos by Adam St. Gelais.

challenge. "Everything looks perfect on paper when you sketch out how an experiment is going to go. When you plop it in the ocean on a bunch of mussel rafts on a working farm…those plans tend to go out the window."

Being adaptable and flexible in their research plan has helped them tackle that challenge, ensuring they're answering questions useful to both the researchers and farmers while also staying out of the way of daily farm operations.

"I think one of the biggest challenges in this relationship is timeline," Byron adds. "In industry you have to move fast and make quick decisions, [but] science takes some time."

She explains that while Moretti may now have access to what the temperature, salinity, or dissolved oxygen is in the water at any particular moment, they likely won't understand exactly how those factors are affecting the mussels until they've done a more in-depth analysis. However, she adds that Moretti has been very patient with the slower process of science. He himself has a master of science degree, and of the farm's three full-time staff members and around seven part-timers, about four also have science backgrounds. Some of the farm's part-timers are actually UNE students.

Overall, the partnership has been a great opportunity for the roughly seven students involved to gain hands-on experience. In St. Gelais's histology lab, the analyses were powered by two students who started off as histology "newbies" and have now gained enough experience that they're able to process samples much faster.

Byron says that not only are students learning how to do solid science, but they're also getting exposure to industry and learning how to be sensitive to industry needs. "They're learning that balance of how to be sensitive to industry and the needs and motivations of industry, which can be very different from academia," she says, adding that students have also gained boating experience. That part of doing research on a mussel farm—being out on the water—is what she enjoys most.

"It's not a sterile environment like some labs are inside," she says. "What's great about being out on the farm is that you're part of it—you're outside, you're experiencing it, it's alive, [and] there's wildlife all around you."

For St. Gelais, having a positive impact on Maine's economy through UNE's research is one of the biggest benefits of the project. Everyone involved hopes the partnership continues well into the future.

"As our company matures, we're becoming more scientific over time, and this [partnership] is one of those big steps," Moretti says. "As the industry in the United States matures more and more, we'll need more people with science backgrounds to keep our aquaculture industry moving forward."

Even the mortality event that led to the partnership may have a future benefit. Byron explains that when mussels are stressed, they release all of their gametes before dying.

"That's typical of bivalve shellfish. If they don't think they're going to make it because they're so stressed out, they're going to throw all of their gametes in the water and hope for the best for the next generation and then conk out," she says. "We've seen declines in wild blue mussels in this area in the past decade and, again, we don't really know what's causing these declines. Having spawning events originating from farms really puts hope, if you will, back in the water that some of those gametes might find a happy place to settle and lead to a next generation of wild mussels."

***Rachel Muenz**, associate editor for* Lab Manager, *can be reached at rachelm@labmanager.com or 888-781-0328, x233.*

RUNNING A SUCCESSFUL CROWDFUNDING CAMPAIGN

RESEARCHERS DISCUSS THE BENEFITS, CHALLENGES, AND SUCCESSES

By Rachel Muenz

Last month, we provided a general introduction to crowdfunding sites for science, why scientists are choosing to fund their research through these platforms, and these sites' plans for the future. Here in part two, we explore the challenges, more of the benefits, and how to run a successful crowdfunding campaign.

The challenges

While crowdfunding has shown it can have an important impact in science, both researchers and those involved in running the sites stress that it's not a magic solution. The method mostly raises fairly small amounts, compared with the funding provided by much larger government grants. And, in most cases, it's not as simple as just posting a project, sitting back, and watching the money flow in.

"It is quite hard to raise money for projects," said Natalie Jonk, founder of the UK-based crowdfunding site Crowd.Science. "A lot of the things that make projects successful are not necessarily the project itself. It's often the scientist's ability to communicate what they're doing and reach people and be really proactive—so, marketing, essentially."

Because crowdfunding research often doesn't result in backers getting a tangible reward, such as a cool new gadget, attracting backers from among the general public can be challenging. Giancarlo Barone, a postdoctoral researcher with 12 years of experience in cancer research, found that to be a key reason he didn't meet the funding goal for his campaign on FutSci, another science-related crowdfunding platform in the UK. His project aimed to create an antibody review website called antYbuddY.com, which would provide high-quality reviews to help researchers avoid wasting time and money on poor-quality antibodies.

▲ *Though the crowdfunding campaign for antYbuddY.com was unsuccessful, founder Giancarlo Barone launched the site with his own money and gained important contacts and industry partners through his campaign. The site rewards scientists for writing journal-quality reviews of antibodies and recently added a protein review section.*

"I had nothing to offer my backers in return. Well, when I say 'nothing,' I really mean nothing physical and, more to the point, something that would belong to them outside of the workplace," Barone explained. "So, while my campaign was very positive and successful in terms of creating a presence and following, it was clearly not enough to raise the funds required."

The breadth of the audience Barone was targeting was also an issue.

"My target backer was very niche, and restricted to scientists who use antibodies," he said. "If I was trying to crowdfund to investigate the role of X in breast cancer, then I could readily widen my target audience to everyone who gives to cancer research."

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Some areas of science have it easier than others when it comes to crowdfunding. Jason Schein, the executive director of the Bighorn Basin Paleontological Institute, found that out when he started crowdfunding paleontological digs on US-based Experiment.com a couple of years ago.

"Paleontology has a bit of an advantage in something like this because it's not rocket science, everybody gets it, everybody's interested in it at least until they're five years old," Schein said. "Everyone goes through a dinosaur phase. It's perfect for something like crowdfunding."

The reward he was able to offer backers—the chance to take part in a dinosaur dig—was also a key aspect of his campaigns' successes. His most recent Experiment.com campaign to fund the institute's 2017 field expedition, for example, raised $41,827—2,707 percent of its goal.

▲*Expedition crew members and students, who signed up for the Bighorn Basin Paleontological Institute's 2017 Field Expedition, lead the way in excavating a dinosaur tibia/fibula.*

"I think people…are wanting to get more from their vacations," he said. "There are plenty of people who just want to go lie on the beach and that's fine, but the people who are doing these eco-tourism or science-themed vacations [are] doing it because they want to get something out of the experience and develop as a person."

He adds that the fact his group's dig wasn't just for fun, but will actually contribute to science, was another factor that attracted backers to his campaign.

"These specimens are going to a museum and will be researched by students and ourselves," Schein said. "People have specifically chosen our dig over others because of the citizen science aspect."

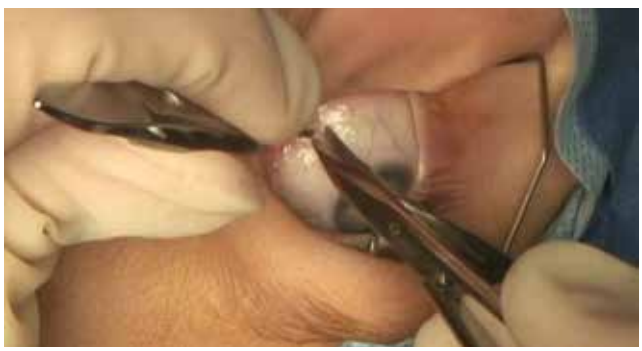
Traditional grants vs. crowdfunding

But is crowdfunding more or less work than going after grants? Again, it depends on the research, but most scientists agree that managing a crowdfunding campaign is hard work, yet different work from writing grants, and while it can be frustrating, it can also be more rewarding.

"I am a full-time postdoc, and full-time dad to four very active young boys," Barone said. "My biggest challenge was sleep deprivation and spending less time with my wife and kids [on] the weekend. All my campaigning had to be done in my spare time, which was after work, early mornings, and weekends. It was pretty relentless for six months but my wife was very supportive."

Susan Culican, an associate professor and director of the ophthalmology residency program at the Washington University School of Medicine, agrees that managing a campaign involves being ready at all hours to answer questions and interact with those interested in the project.

"If somebody asks a question at seven o'clock at night…you've got to answer it right now," she said. "So, you have to be on top of things. It's not a lot of time; it's lots of little bits of time instead of big chunks of time."



▲*Eye muscle surgery. Susan Culican's crowdfunding campaign will support a research project that aims to determine if the general public can rate eye surgeons as well as experts. If they can, this could provide a cheaper, yet still reliable, option of determining if eye surgeons are ready to practice on their own.*

Ruth Morgan, founder and director of the University College London Centre for the Forensic Sciences, added that the typical crowdfunding audience is a lot more diverse than panels that review grant applications, and it's more difficult to determine what will click with the general public. "If you're trying to run a crowdfunding campaign, you've got to really think as laterally as possible and think of all the different angles and who might be willing to support you and where your message is going to land well." She said that with traditional grant applications, the process and the way applications are assessed is clearly stated. There is also a larger community of researchers who have gone through the process before who can provide advice and feedback.

"In crowdfunding, you're very rarely doing the same things again and again; you're trying lots of different things," she said. "You can't chart your progress in quite the same way, so you never quite know what's going to have impact and what isn't before you try it. I certainly learned new skills that I didn't have before."

▲ *The UCL (University College London) Centre for the Forensic Sciences is seeking to crowdfund £1 million to create a forensic evidence research laboratory, which will focus on preventing miscarriages of justice.*

However, those interested in crowdfunding aren't completely without guidance. All the science-specific crowdfunding platforms offer tips and assistance, both online and by phone, to help researchers through the process. And there's a growing community of scientists who have "been there, done that" and are more than willing to share what worked for them in their campaigns.

Schein, for example, has become an unofficial expert in crowdfunding paleontology projects. A couple of years ago, Experiment.com ran a grant challenge in which they recruited several campaigns with the same general theme, and the top three crowdfunding campaigns received extra money from the site. Schein was hired to run the paleontology grant challenge, recruiting the projects and helping researchers through the process.

"One of the things that I told them all the time is, it's far easier and less time-consuming than writing grant proposals, but it is work," he said. "It's a lot of online work. You've got to put in the legwork on Facebook and Twitter—you have to get the word out there. Basically, it's about volume. The more people you get to lay their eyes on your site on Experiment.com, the more likely it is to get enough donations."

Another important part is to make the language accessible to a general audience. It should be written in a conversational way, as if you were explaining your research to a 12- or 13-year-old, rather than to those reviewing a grant application, he added.

"That's not to be condescending to the broader public, that's just how you have to write it so that everyone understands," Schein said. "Write it simply, make it short, get to the

point, tell them why it's exciting, why you do this, why you love it, make it a little bit personal, but it has to be simple and it has to be good."

Interacting with backers and promoting the project on social media platforms is important to get the word out about a campaign, but it's not something all researchers are comfortable with.

"You have to have access to a lot of social networks and that's not my skill set," Culican said. "What I ended up doing is, some of my collaborators are younger people with more social-network-savvy connections and then they started sharing it [the campaign] and the funding picked up."

Her project was eventually fully funded by the deadline, though not without some hiccups along the way.

"The biggest snafu was the fact that I did not set up the account to be 501(c)(3)-compatible in advance of the campaign, so donors could not take the donations as a tax break," she said. "You can do this, but it needs to be in place before the go-live date. I'd fix that if I had to do it again."

Connecting with the right audience is still a challenge for her going forward and something she says she'll think about before doing another crowdfunding campaign.

Jamie Barras, head of the Humanitarian Technologies Lab in the Department of Informatics at the UK's King's College London, faced similar challenges in his own campaign. Initially, the lab had a partner with a wide social media network that was going to help promote his team's project. However, that partner pulled out just before launch and they didn't have a backup plan. To make matters worse, they launched in November 2016, the same month as the US presidential election. "When we came knocking, both social and traditional media were a little preoccupied with other things," he said.

▲ *Dr. Jamie Barras, head of the Humanitarian Technologies Lab in the Department of Informatics at King's College London, aimed to support field trials of an explosives detector to remove landmines left after conflict through his campaign. Here, team member Blaz Zupancic demonstrates the system at an event at the UK Parliament in April 2016.*

It's not just about the funding

Whether successful or unsuccessful, or still in the midst of their campaigns, all the researchers we spoke with found crowdfunding to be worthwhile. As mentioned in our September article, the key benefit was engaging the public and getting their research out there, something that doesn't happen when applying for a traditional grant.

"Getting people interested in and literate in science right now is a major issue," Schein said. "We've got to do whatever we can to get people more interested and aware of the science that happens in their daily lives. I think one of the best benefits of crowdfunding is that it forces scientists and science students to communicate more effectively with the broader public. You're not going to raise all your money from other scientists, which means you have to talk with people who are not scientists about your science in an effective way that makes them want to be interested, if not donate. That requires some skill,

some training, [and] some practice." Morgan agrees that getting science and the issues surrounding scientific funding into the public eye is a key benefit to crowdfunding.

"People are trying to do different things and question the best ways we can [fund research] and I think that's quite exciting for science," she said. "I think there's going to be some very interesting and valuable science that's going to happen as people navigate their way through [crowdfunding]. Ultimately, I think it's going to really help us make sure that the science we're funding is actually going to have impact."

Though Barone's campaign was unsuccessful, he ended up funding antYbuddY.com using his own funds and it has been up and running for a few months. And the contacts he made through his campaign have proven valuable.

"Although I missed my crowdfund target, I did gain contacts and a social presence that have helped me further down the line," he said. "It has also given me experience in areas outside of science that I use today."

Barras, though his campaign was still only 56 percent funded at the time of writing, is also positive about the experience.

"We haven't reached the full amount, but we have made enough to support viable field trials, so the effort has been worthwhile," he said. "First and foremost, it was great to read from backers [about] why they backed us; it reaffirmed in us the real-world value of our research. More widely, we learned a lot both as researchers and academics about public engagement in the [relatively new] world of social media—and those lessons are being taken up by others in the university."

As science-specific crowdfunding matures, the benefits seem like they'll only get greater and greater.

"I think that crowdfunding for science is a really exciting space," Jonk said. "I think that it will work really well in the future for both small projects and large projects. At the moment, we're just scratching the surface and it will take time for it to be able to fund really [large] projects on a regular basis, but it will happen eventually."

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KEY CROWDFUNDING ADVICE FROM THE RESEARCHERS AND CROWDFUNDING SITE MANAGERS WE SPOKE TO:

- Do your homework—find out which platform is best for your project, and who your potential backers are, before launch
- Promote the project before launching so you have a group of backers ready to go
- Use whatever networks you have at your disposal to get the word out (friends, family, colleagues, etc.)
- Promote the project through both social media and traditional media during the campaign
- Get help both from others who have crowdfunded and the platform you're campaigning on (Experiment.com, Crowd.Science, FutSci, Kickstarter, etc.)
- Make sure your message is clear and accessible to a general audience
- Ensure your reward structure is clear
- Be prepared to answer questions and interact with potential backers at all hours
- Be prepared for lots of hard work!
- Don't get discouraged
- Make sure to set up your campaign to be 501(c)(3)-compatible in advance

COMMON MISCONCEPTIONS ABOUT USED LAB EQUIPMENT

VENDORS SET THE RECORD STRAIGHT

By Erica Tennenhouse, PhD

Purchasing preowned equipment can be a good cost-saving solution for labs that are tight on funds. However, those tasked with purchasing equipment sometimes express concern over buying anything other than brand new. While used equipment is not for everyone, certain misconceptions about preowned equipment persist and may deter those who would benefit most from it.

All vendors are not equal

Although used-equipment vendors play in the same sphere as one another, they are not all the same, says Octavio Espinosa, senior director of sales, marketing, and operations at BioSurplus (San Diego, CA). "We have different offerings, we have different customer-centric approaches, and perhaps different quality." Ceylan Bilgin, VP of marketing at International Equipment Trading (Mundelein, IL), adds that it is unfortunate when one negative experience deters a customer from ever buying preowned equipment again. James McCloskey, manager at American Instrument Exchange (Haverville, MA), would agree: "Some sellers might not be as familiar or well-versed in lab equipment as a company like ours, so the equipment may not be described properly or fully tested. An experience with a seller like that can contribute to a bad reputation for used lab equipment."

> "Although used-equipment vendors play in the same sphere as one another, they are not all the same."

Quality is key

Potential customers often question the quality of preowned equipment, but for many vendors, quality is the top priority. "We focus on taking equipment out of working labs…we don't like to acquire equipment that's been sitting in storage or sitting unused," says Reid Hjalmarson, director of marketing at BioSurplus. "We want to target our equipment supply from the best of the best." American Instrument Exchange will provide pictures or videos of the equipment to customers prior to shipping it out, says McCloskey. "We also thoroughly test equipment to make sure it works to the manufacturer's specifications. If customers have particular testing requirements, we'll make sure these requirements are met during testing, and we can provide the test records to customers," he says. At International Equipment Trading, Bilgin encourages potential customers to visit the facility to see the instruments in person. "We've had customers actually run the instrument at our facility," she says.

Service contracts and warranties are available

Those in the market for preowned equipment need not worry about a lack of warranties or service options. "We have warranties up to two years available; it's usually just an additional cost," says Bilgin. International Equipment Trading also offers custom warranties, such as parts-only warranties and full warranties with service agreements. On the subject of service, Bilgin explains: "We do service our instruments, and we make sure when we're getting an instrument that it actually is serviceable by the manufacturer."

American Instrument Exchange offers a 90-day warranty on all their equipment, which is typically plenty

of time to determine whether a piece of equipment is functioning properly, says McCloskey. He notes that there are times when manufacturers phase out support for certain pieces of equipment. "If we can't source replacement parts to repair equipment, then we may not be able to sell that equipment," he says. However, as he points out, some repairs don't require OEM parts: "For example, we might be able to source a new compressor for a malfunctioning freezer from half a dozen different suppliers."

> "Those in the market for preowned equipment need not worry about a lack of warranties or service options."

At BioSurplus, customers are entitled to a 30-day money-back guarantee, and other options are also available. "We make sure that our customers have the support they need," says Hjalmarson. For example, "If a customer wants to purchase a piece of analytical equipment under a one-year full-service contract with preventative maintenance and a guaranteed response time, we know which individuals to reach out to and will help foster a relationship between those two parties." Espinosa thinks that end users sometimes view providers such as BioSurplus as providers of only whole, intact working systems. "In fact," he says, "we are a good resource for parts, repair, and service."

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

SOURCING TOP TALENT

TIPS FOR TALENT ACQUISITION FROM RECRUITING EXPERTS

by Donna Kridelbaugh

In this digital age, a hiring manager may think he or she can be a recruiting pro with a few LinkedIn searches and connect requests; but that is a misperception of all that a recruiter does. The recruiting process requires expert research skills to identify potential candidates who will fit the defined qualifications, often requiring targeted approaches and connections to industry-specific circles.

Additionally, Dave Jensen, managing director of CTI Executive Search, a unit of CareerTrax Inc. (careertrax.com), explains, "That's [LinkedIn searching] such a small part of the job of being a recruiter. Our work goes far beyond that—it goes into understanding how a person thinks and what makes them tick, what decisions they have made in the past, and what decisions they would make in the future."

Recruiters are experienced in sourcing and identifying top talent who will also be a good match culturally for the company, because they know what traits to look for and what questions to ask of references. As Jensen elaborates, "You know what kind of person is going to work and not work. You have to be a good student of human nature to be able to figure that out. But that's what companies count on when they're paying that bill. They want to have that kind of antenna on the part of the recruiter."

John Pender, global program director with Korn Ferry Futurestep (kornferry.com), points out that more and more organizations are turning to recruiting project outsourcing because it is a cost-effective model that delivers the best talent in the end.

This model includes access to the latest technology in the recruiting industry. Pender highlights that his company offers a number of web-based applications to streamline the recruiting process, including research-based assessment tools and targeted job-posting services. In terms of cost effectiveness, Jensen says a recruiter becomes the "champion" for a position to be filled and moves the process along. Oftentimes, he can have a new hire secured in as little as two or three months, expediting the time to productivity for his clients by hiring sooner. Reputable recruiting firms also have a placement guarantee, which typically ranges from six months to one year, and will source a replacement for free if the initial hire does not work out.

As Jensen remarks, "People think of recruiters as only being interested in making a placement and then going away." However, he further explains, "We're involved in that person's indoctrination as a new employee, checking in regularly and making sure everything is smooth." Therefore, recruiters are committed to helping new hires transition into their new roles and promote overall retention efforts. This benefit is a huge savings in the long run because it is expensive to start over and retrain a new person.

An alternative to the traditional recruiting model is the use of an online, community-based job-listing service. For example, Bio Careers® (biocareers.com) offers employers access to a database of highly qualified job seekers with graduate degrees from top institutions across a breadth of disciplines in the life sciences.

Employers can request updated information directly from registrants and target candidates in specific scientific niches. Companies can further engage with potential candidates through virtual events (e.g., career fairs, webinars) hosted by the site.

Nick Folger, founder of Bio Careers, notes that this type of platform can provide employers an intermediary option that is less expensive but still "offers a tailored approach to the best science talent in the market."

Overall, recruiters are at the forefront of hiring trends within their respective industries, and thus they possess a wealth of knowledge related to best practices in recruiting. It's worth every hiring manager's time to connect with recruiters on a regular basis to stay updated on the latest trends.

Here are a few pro tips that the recruiting experts featured in this article had to share with lab managers based on recent trends in the field.

Tip #1: Showcase your company culture and people

Pender points out that a powerful trend in the recruiting world is a renewed focus on company culture. As he explains, "This [trend] is being driven by younger generations in the workforce who are more motivated by culture, environment, and 'me' than the almighty dollar. Compounded with the prevalence of [employer] rating sites like Glassdoor, companies are taking a new and fresh look at their image to ensure they are attractive to millennials and will be perceived as an employer of choice."

Another area of importance is attracting a diverse pool of applicants for positions, which is in line with recent hiring initiatives. Therefore, companies need to take an introspective look at their work environment to make sure it is welcoming and supportive of differing needs.

To attract diverse and talented applicants, Jensen emphasizes the need for companies to maintain a continuous web and social media presence. As he explains, "For example, a lab can use a LinkedIn page to talk about why it's a great place to work. Perhaps the organization's home page on the web can feature stories about individuals who have succeeded there, and the different kinds of roles they are in. Pay special attention to diversity recruitment and gender in those stories."

Tip #2: Add some marketing flare to the job description

Another marketing aspect is how well the job description is written to appeal to the interests of potential candidates. As Jensen notes, "There's an art to writing a good job description—it's almost as if you have to get the job away from human resources and into the hands of a marketing person."

While human resource departments have specific requirements to include in a description, Jensen advises that the boring "humdrum" qualifications be left off and included in a supplemental document that can be provided during the interview process. To jazz it up a bit, he suggests, "Talk about why it's a good career opportunity, and make sure you emphasize some of the most interesting aspects of the work. You can also write up that job description in a way that will attract diverse applicants."

Likewise, Pender encourages employers to think about what would attract top talent to the position and develop a script that really speaks to the passions of the potential candidate. It is especially important to have an engaging and well-written job description that can be easily passed along during referrals and for targeting passive job seekers to pique their interest, even if they aren't actively seeking out new opportunities.

Tip #3: Practice business basics in the hiring process

Jensen mentions that employers would be surprised by just how much practicing "business basics" can improve the image of a company to future prospects. This means treating applicants with respect throughout the hiring process, from acknowledging receipt of an application to providing constructive feedback on why a person wasn't hired or a good fit for the company. As Jensen explains, "Word of mouth about employers, what they're like and what kind of reception they gave people, goes a long way, especially negative comments. They just have such a long-term effect in the market place."

Tip #4: Be realistic about job qualifications

In any field, there are positions that are hard to fill due to competition from other industries and/or a lack of qualified individuals. As further compounding the problem, Pender sees employers excluding large pools of potential candidates by making job qualifications too restrictive. For instance, a four-year degree is rarely necessary for entry-level positions, and the organizational knowledge gained on the job is invaluable. In this case, he advises, "You can land some wonderfully talented people

for entry-level work with a two-year degree, and then proceed to groom them internally as they work toward a four-year degree."

Likewise, Jensen notes, "Sometimes your hiring manager will actually make it much more difficult to find a hire because he or she will go through their shopping list of everything they need for that department and add those things to the job description. You end up looking for 10 hard-to-find skills when only six or seven [are] all you really need for the job." Thus, being realistic about expectations will make it easier to find a diverse group of candidates from which to choose.

Tip #5: Implement talent management strategies to fill niche positions

In addition, Jensen references that there are some "old-school jobs" for which many universities are no longer training graduates in these traditional fields of study. For example, genetic engineering of crops has taken center stage with graduates trained in molecular biology and genetic techniques. However, this is creating an issue for agricultural companies still looking to hire scientists trained in classical plant-breeding methodologies.

To address this mismatch, Jensen encourages companies to consider using a recruiting firm that is well connected in this scientific niche. Additionally companies can stay connected to professors at institutions (e.g., invite them to be on an advisory board) who are still training graduates in these fields so employers can have their pick of the crop of talent.

Jensen suggests another solution is to develop internal mentoring programs to train new hires in needed skills. As he states, "Sometimes you have to grow your own, so to speak, so you hire them young. Treat them right and foster their careers, and they will become key players in your organization."

Donna Kridelbaugh *holds an advanced degree in microbiology and is a former lab manager. Connect with her on Twitter (@science_mentor) and visit her website at http://ScienceMentor.Me.*

DIGITAL DATA IN THE LAB—WHAT NOW?

REAL-TIME ANALYTICS, MULTIFACTOR TREND ANALYSIS, AND DATA VISUALIZATION

by Stephen Hayward

The continuing trend toward digitalization of data in the lab produces more and more data every year. The drive to "go paperless" is a strategic initiative that offers demonstrable operational benefits in improving productivity, reducing cycle times, and enabling organizations to leverage experimental and operational data generated along the entire research-development-manufacturing continuum. Organizations looking to capture and leverage this data effectively are exploring solutions such as data lakes to help manage the vast quantities of data being generated, and to leverage it in an efficient manner.

▲ *Today's labs can better leverage their data through digital capture, data standardization, and cloud-enabled technologies. Photo credit: BIOVIA.*

Digitalized data

When laboratory instruments first started producing digital files, they were simply stored on the local computer disk. With removable storage and networking abilities, files could be collected and collated into a basic folder-based repository. While many view this as hopelessly outdated, the reality is that some labs still rely on local file storage for simplicity and cost effectiveness, viewing more modern and automated systems as too complex and costly. The reverse is also true, where many companies are willing to invest in more advanced data storage solutions to leverage specific capabilities and to preserve and reuse data in the future.

The rise of laboratory informatics systems, such as electronic lab notebooks, laboratory information management systems, and laboratory execution systems, have furthered the proliferation of digital information generated by the lab. However, these disparate systems have also created multiple data silos, with data accessible only through proprietary vendor software and with incompatible data formats. So, although digitization has been achieved, true digitalization (the effective use of digital data for scientific and business purposes) often remains an elusive goal.

The natural reaction is to try to remove the artificial barriers, placing everything in a single common repository, such as a scientific data management system (SDMS), to ease data access. Broadly speaking, an SDMS falls into the category of a data warehouse (or data mart) for scientific data, where the schema for data storage must be predefined—the data is processed and structured based on its anticipated use.

A data lake stands in contrast to a data warehouse in a few key ways. First and foremost, a data lake employs schema-on-read; appropriate processing is applied only when data is queried. To enable this, raw data can be stored in structured, semistructured, or unstructured forms, and is

tagged with appropriate metadata and a unique identifier. The architecture is flat, rather than the hierarchical strategy of traditional file systems, and object-oriented, making it much easier to scale and manage.

By storing large amounts of unstructured data from disparate sources, such systems can process unique and novel queries, combining and processing data as necessary, on request. The schema-on-read distributed-computing aspects of a data lake enable new ways of combining and interpreting data, often independent of the data's original purpose. It is thus quite common to equate a data lake with "big data," but they are not the same thing. Big data analytical efforts can be enabled by a data lake, but still require specific goals and processes to be in place, along with strong governance of the projects. Without strong oversight, data may not receive useful metadata tagging and it may still remain effectively siloed from some company stakeholders.

> "Disparate [informatics] systems have ... created multiple data silos."

Data management and standardization

Although a data lake exists in large part to store disparate structured and unstructured data in an unsiloed manner, it is still important to consider some standardization of the data heading into the lake itself. In most labs, there is a variety of analytical instruments from different vendors, all creating data in various and often proprietary formats. Analyzing and/or combining the data for any type of analysis is a time-consuming process, often involving manual steps and data transformations. By parsing analytical data into a common or standardized format, such as those being developed by consortia such as the Pistoia Alliance or Allotrope Foundation, at the time of acquisition, an organization can avoid manual processes and transcription errors. Additionally, standardized data is naturally easier to combine and interpret alongside similar data files in the future.

During the parsing process, relevant metadata can be applied to the analytical data as well. Metadata helps add context, such as the experimental conditions, equipment used for capture, project parameters, users and materials involved, and other relevant information to help identify the data for future use. The use of metadata tags is extremely powerful for analysis, but care must be taken to properly define the terms and variables used; misuse or undisciplined usage across an organization can render advanced data analysis incomplete or make results misleading.

"The schema-on-read distributed-computing aspects of a data lake enable new ways of combining and interpreting data."

At the very least, the vocabulary of the metadata needs to be properly defined, so that terms are uniformly applied to analytical data when it is captured and parsed. For example, using only "weight" instead of "weight (g)," "Weight-mass," or "mass" (among other variations) makes it much harder to cross-reference in a data search. After the common vocabulary is defined, the taxonomy and ontology for data sets should also be defined. The taxonomy is a hierarchy that defines how the various terms of vocabulary relate to each other—in our example, the unit (grams) would be a related subset of the "weight" tag. The ontology is a controlled vocabulary, where both the hierarchical taxonomy relationships and the relationships between hierarchical branches are defined—an ontology describes how the tags interrelate with each other, and allows unique and unexpected queries to be performed. A weight measurement from a certain instrument has a specific location, and is normally used by certain individuals for a certain subset of available tasks—these relationships can be defined by the ontology.

With properly defined metadata tagging and data parsing into standardized formats, the data can be automatically captured and fed directly into an enterprise data lake. The process of storing, leveraging, and reusing data becomes more efficient, more powerful, and more accurate. But at the same time, the data lake helps enable advanced real-time analytics and multifactor trend analysis. By automating the data capture and storage process and providing access to the data across the organization, the results are instantly available for trend analysis.

Organizations are still learning how to best leverage all the data that is being made available from their digitalization efforts. But it is clear that the multitude of data, along with the context provided by metadata, provides ample opportunity for new, advanced analytics efforts and data visualization. At a glance, anyone can investigate resource use (materials, instruments, lab space), monitor lab activity and identify analytical bottlenecks, or check and predict instrument maintenance and calibration needs or check instrument performance. Additionally, the contextualized data

and the relationships defined by the ontologies facilitate multifactor analytics, enabling manufacturing trendline analysis and detailed batch and quality analysis.

Looking ahead

As with many lab informatics solutions, the current trend is also toward the cloud. In some cases, the entirety of the project can be hosted on the cloud, from the data-lake storage to the lab informatics and analytics applications, but a popular option is on-premises data storage with the computing portion hosted as a cloud-based service. This arrangement leverages more cost-effective data storage and the power of purpose-built, parallel-processing systems on demand from the cloud. The well-known data-lake infrastructure Hadoop, with its wide range of modules that can be tricky to configure, has started to fall out of favor in the face of more out-of-the-box cloud-based solutions. Existing cloud vendors are well positioned to provide either the heavy lifting of analytic computing power, or a complete cloud-based data-lake solution.

As organizations continue to further their digitalization efforts, it is clear that finding ways to most efficiently leverage the data and knowledge generated internally is a strong driving force. As some barriers to data access are removed through solutions such as data lakes, others are unwittingly erected, with siloed access to organizational analytics data and dashboards. Unlocking and leveraging the analytics aspects of a business, perhaps in connection with the move toward the cloud, will allow the true power of big data to be realized.

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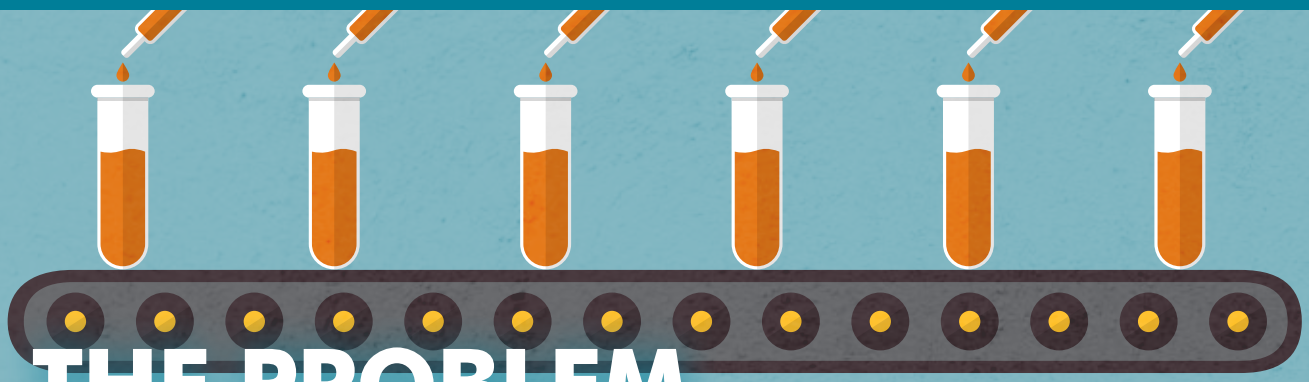

THE PROBLEM OF REPEATABILITY

TRANSFORMATIONAL TECHNOLOGIES THAT ARE MAKING LABS "SMART"

by Sridhar Iyengar

Despite deep commitments to solving some of the world's most complex problems, many researchers and lab staff are still facing an age-old problem: the inability to reliably repeat experimental outcomes. In fact, according to a study conducted in 2016 by *Nature* magazine, more than 70 percent of researchers have tried and failed to reproduce another scientist's experiment, and 50 percent have also failed to reproduce the results of their own experiments. While those statistics are surprising to people outside the research field, they do not come as a shock to most inside the industry.

So even with the massive technological advancements we've seen in the past decade, why does this issue persist? For one thing, the scientific community, despite the sophisticated diagnostic tools it has access to, is still very traditional and process-oriented—comfortable with the tools they've trained with and used for decades. As a result, many scientists, even those fresh out of school, still use the ever-reliable pen and paper to log instrument data and experimental observations before later transferring information to spreadsheets, electronic lab notebooks (ELN), or other programs. They then use the computing capabilities of those systems to delve into and manipulate the data, but the manual process of acquiring it is the hurdle.

> "More than 70 percent of researchers have tried and failed to reproduce another scientist's experiment."

Beyond frustration and inconvenience, the real cost of the widespread repeatability issue is slower time to market for lifesaving therapies and innovations. So how can we leverage technology to support and augment the way researchers and lab managers work, without causing them to change their processes? Below are three transformational technologies that are making labs "smart" and helping teams tackle repeatability.

Intelligent sensors

The laboratory environment has the highest potential for transformation and far-reaching benefits gained from becoming smart, and intelligent sensors play a major role in unlocking that potential. Sensors—data-gathering devices already widely used in personal fitness trackers, the built environment (think smart homes and smart buildings), mobile devices, and industrial infrastructure—have numerous applications in the research laboratory. From bioreactive sensors that are developed and used in complex research environments to intelligent sensors that enable teams to track contextual variables such as temperature, humidity, and light levels, sensors are a key diagnostic technology that can be harnessed to address the repeatability issue.

The broader deployment of sensors in the lab environment has been driven by dramatic reductions in size and cost in the past decade. But unlike simple activity-tracking applications, intelligent sensors—optimized for the research environment—have the potential to accelerate researchers' work by enabling them to cost-effectively measure and track minute details that may have been

impractical or cost-prohibitive to monitor previously. The key is for intelligent sensors to be part of a system that automatically aggregates and displays critical data.

Data and data visualizations

With new, intelligent, sensor-based systems, laboratory managers and research teams have access to entirely new data streams and real-time visualizations, providing insight into the physical environment where experimental research is conducted. By identifying and quantifying many of the contextual variables that are often not tracked or documented, teams have visibility, down to the smallest detail, into the exact environmental conditions they need to replicate. This includes everything from tracking temperature throughout the entire protocol, observing the time something is in an oven or freezer and recording any changes, monitoring humidity within a space, and noting any variations in the way a piece of equipment performed (for example, if it heated up or cooled off faster than expected). With access to this information, teams can standardize the environmental aspects of protocols and correlate experimental outcomes with those variables, recognizing exactly where a variation that caused a different outcome occurred.

For example, when performing an experiment where a sample is placed in an oven, it is now possible to understand whether the conditions in the oven and on the sample plate conform to the protocol defined by the original experimenter. Having access to high-resolution data makes it possible to see whether the steps are being followed and, if necessary, to refine the protocol with micro steps, including specific contextual conditions specified so that the outcome is reliably successful.

Remote access

When sensor data is collected, aggregated, visualized, and available to researchers and lab staff via cloud-based services, teams can monitor and track contextual variables and validate equipment performance—even when they're not physically in the lab. Whether remotely monitoring the lab environment to ensure that the ambient conditions on the bench or in animal rooms conform to the protocol or ensuring that critical equipment is performing as specified, remote access is critical, allowing staff to use mobile devices for data access, alerts, and notifications.

While homeowners and industrial operators have access to smart, sensor-rich devices to support their operations, the laboratory market has been underserved until now. With the arrival of a range of options, lab managers and researchers now have access to sensory networks that hold the promise of streamlining the process of gathering and analyzing critical data. The question is how they will use that data. For monitoring equipment? Improving protocols? Improving repeatability? Absolutely.

Ultimately, scientific research is what underpins innovation and progress; adopting technology to accelerate the efforts of scientists will be not only a competitive edge but also what creates long-lasting value. In a world where science-based enterprises are increasingly competing for funding and resources, investing in a smart lab is not just a good bet—it's a necessary investment.

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A GOOD DEFENSE

PERSONAL PROTECTIVE EQUIPMENT

by Vince McLeod

There is an age-old sports cliché that goes "the best offense is a good defense." Many coaches at all levels have used it and to great success. The Safety Guys believe it works well as a guide for your safety program as well.

Most of today's modern laboratories contain serious hazards, either from toxic or dangerous chemicals to equipment. And we know, as sure as the sun will rise, that accidents happen. Here is a recent example from literally hundreds that could have occurred in your lab.

A researcher was nearly killed and the laboratory seriously damaged when a distillation flask exploded. The researcher had performed the methanol-ether extraction hundreds of times, but apparently the ether had formed some peroxides due to age. Since he was using only 250ml of material, the resulting flash fire burned out quickly. But it set his synthetic shirt on fire, as he had left his lab coat on the coat rack. Fortunately, it set off the building's fire alarm.

The alarm alerted a coworker down the hall, who quickly found the researcher collapsed in the hall. A glass shard had severed the artery in his left forearm, but the coworker removed his lab coat to put out the flames on the researcher's shirt and then applied a tourniquet.[1]

Most lab and building managers probably know OSHA requires engineering controls as the first line of defense against workplace hazards. Source control through engineering methods can usually eliminate hazards from the workplace altogether or isolate them from workers.

Examples of engineering controls might include proper ventilation, machine guarding, hazardous product substitution, biosafety cabinets and ventilated work stations, and anesthetic gas scavenging systems, to list a few. Protection concepts are built into current OSHA standards and are found in 29 CFR 1910 Subpart I - 1910 Subpart I, Personal Protective Equipment.[2]

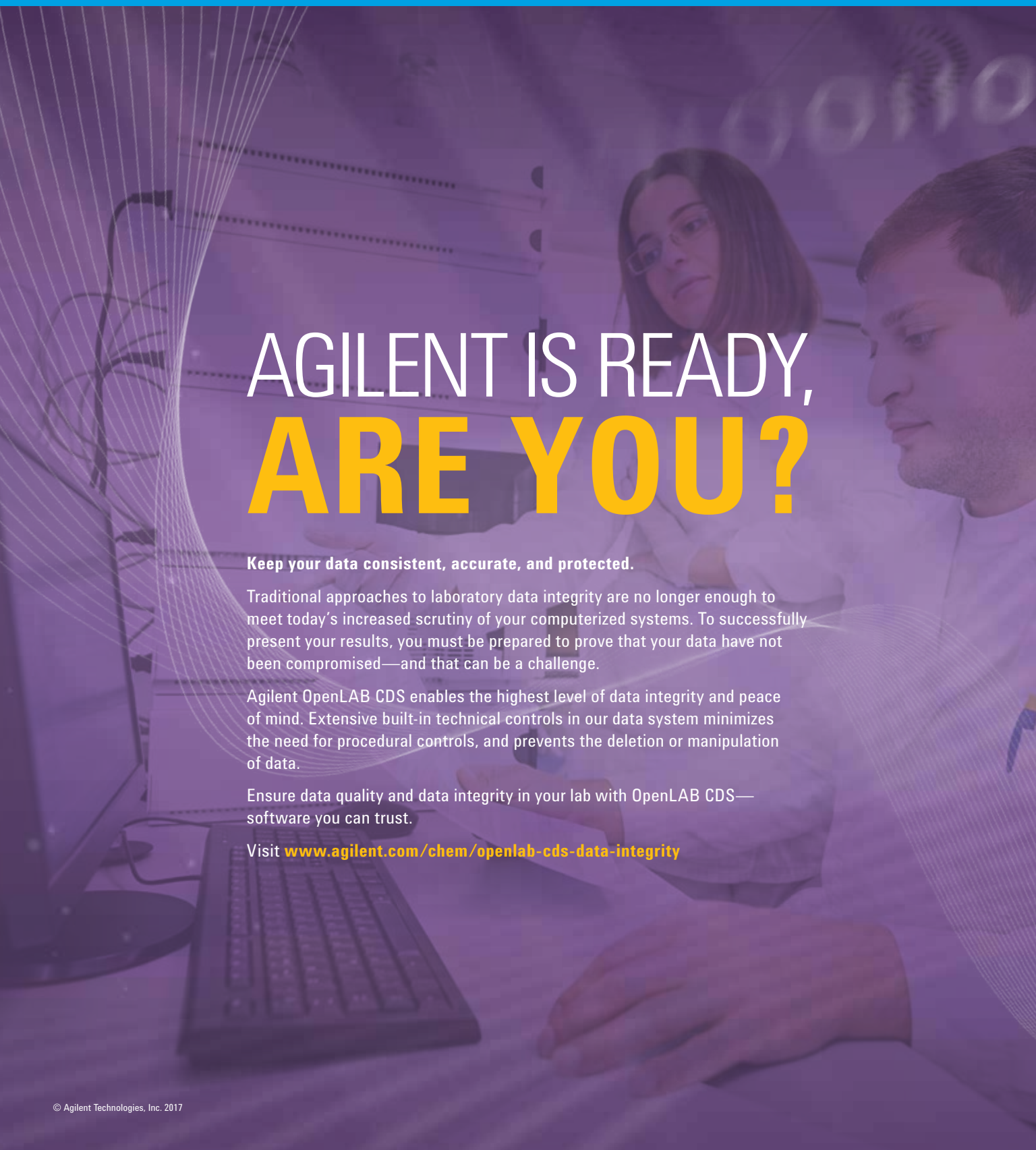
But engineering controls are not perfect. And although controlling a hazard at its source is the first choice, it doesn't mean we can ignore personal protective equipment (PPE). PPE is our last defense because it means the hazard is actually at hand—and without PPE, hazardous exposure or injury may very likely occur.

PPE includes items such as gloves, lab coats, footwear, face shields, goggles, hearing protection, and respirators. Unfortunately, the researcher in the aforementioned incident was not wearing a lab coat when the flask exploded. If he had been, it might have provided protection and certainly would have reduced injury.

> "Without PPE, hazardous exposure or injury may very likely occur."

The OSHA PPE standard states, "Employers are required to determine if PPE should be used to protect their workers. If PPE is to be used, a PPE program should be implemented. This program should address the hazards present; the selection, maintenance, and use of PPE; the training of employees; and monitoring of the program to ensure its ongoing effectiveness."[2]

The OSHA standard requires documentation that the equipment selection is based on the hazard, employees have properly fitted equipment, they are trained on the equipment assigned, and the equipment is kept in good repair. A good PPE program should also include regular evaluation of the program to ensure the equipment used is appropriate for the job and the employees are actually wearing and maintaining it properly. Below we offer some tips on successfully using these major PPE program elements.



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Workplace survey

The first step in identifying hazards and proper controls is conducting thorough workplace surveys and job hazard analyses (JHA). It is through these processes that we figure out the potential risks associated with a particular job and devise ways to control or eliminate them before an injury or accident occurs.

The JHA technique looks at the individual tasks connected to a job and then identifies controls for the hazards in each job step. When the hazard—for example, unexpected splashes or explosions—cannot be removed or controlled adequately, PPE must be used if the work process is to continue.

Determining exposure from toxic materials may be required and entails air sampling and analysis that are often best conducted by a safety and health professional.

Selection of appropriate PPE

We recommend using a system that considers each body area: eyes, face, head, hands, feet, ears/hearing, respiratory system, and the whole body. For the splash example, the JHA should identify eye hazards (chemical/biological splash, impact) and chemical splash on the body, face/head, and hands, etc. Protection from potential splashes into the mouth or the eyes and face might well be prevented using chemical goggles and a face shield.

Gloves should be selected that prevent skin contact and contamination. This should involve consulting chemical compatibility charts (available from all major chemical glove manufacturers or distributors) before a decision is made.

Employees should also be given a choice based on personal comfort and preference, where possible, of several different PPE options that meet the safety requirement. OSHA provides good assistance through the use of eTools and other guidance.[3]

Fitting

If PPE does not fit properly, its effectiveness is often drastically reduced. If you have safety glasses that slide down your face because they are too large, protection is lost. Respirators must fit properly, or they are ineffective. There are respirator fit test methods using specialized equipment to quantitatively assess fit or qualitative challenge tests where isoamyl acetate, saccharin, bitrex, or irritant smoke is used. Gloves may be too large, creating entanglement hazards, or too tight. Once the proper fit is identified, it should be noted in the employee's records.

Training

Workers need to know:

- When PPE is necessary—what jobs or areas require use of PPE.
- What PPE is necessary—all the PPE required for specific tasks.
- How to properly check, put on, take off, adjust, and wear assigned PPE.
- Limitations of the PPE—For example, you don't want someone wearing a dust mask for protection against anesthetic gases. There have been injuries and fatalities resulting from misunderstandings of the limits of PPE use.
- Proper care, maintenance, useful life, and disposal of the PPE.

Training should be conducted by a competent person or safety professional who completely understands these key points and can answer questions accurately. The workers should have a thorough understanding before being allowed to conduct work requiring the use of PPE. Remember, OSHA inspectors will often quiz workers to see whether they understand why they are wearing PPE, the hazards they are protecting themselves against, and how they care for and store their equipment.

Maintenance

All too often we see old, damaged, and potentially dangerous PPE used by employees. Examples include dirty, misshapen respirators with ancient cartridges or missing valves; glasses or goggles so scratched that one could not imagine wearing them; filthy, torn earmuffs; or contaminated gloves or coveralls.

PPE must be taken care of in order to adequately protect the worker. Poorly maintained and inadequately cleaned equipment can actually put workers in greater danger. Making sure that equipment is properly maintained is a key component of the program.

Monitor the program. As PPE is the last defense for our workers, it is very important to audit the program on an ongoing basis. This would include thorough investigation of any accidents or near-misses involving the use of PPE.

In addition to the excellent resources provided by OSHA online, equipment vendors and their technical support groups can provide information on specific protective equipment. Many people equate safety with PPE. It can be very effective in preventing injury, but it is also the most vulnerable to failure, as it relies on people to consistently and properly use it each time. Develop and implement solid JHA and PPE programs to ensure your employees have maximum protection.

Resources

1. Flask Explosion Incident, University of Wisconsin, Milwaukee, WI. http://www.ehs.ucsb.edu/files/docs/ls/Flask_explosion.pdf
2. Personal Protective Equipment, US Department of Labor, Occupational Safety and Health Administration. Washington, D.C. http://www.osha.gov/SLTC/personalprotectiveequipment/index.html
3. Eye and Face Protection eTools, eMatrix, Expert Advisors and v-Tools, US Department of Labor, Occupational Safety and Health Administration. Washington, D.C. https://www.osha.gov/SLTC/etools/eyeandface/index.html

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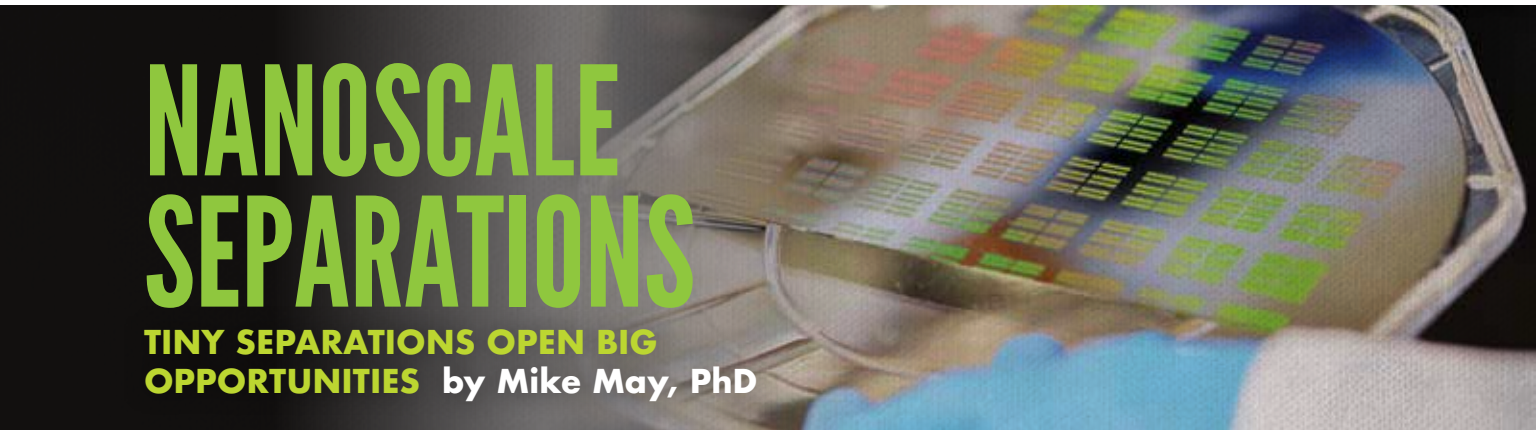


NANOSCALE SEPARATIONS

TINY SEPARATIONS OPEN BIG OPPORTUNITIES

by Mike May, PhD

Working at billionths of a meter—a nanometer—makes some things complicated and others greatly simplified. With membrane-based separation, scientists and engineers can work with particles in the 1–100 nanometer range. These tools can remove viruses from a sample, concentrate nutrients in foods, desalinate water, and much more.

Many industrial processes require isolation of nanoscale molecules from a mixture. "Enzymes—pervasive across industries from medicine to cleaning products—must be isolated from the cultures or the raw products they're produced in," says Benjamin Wunsch, research scientist at IBM Research (Cambridge, MA). "The growing field of biologics, which are typically peptide-based medicines, requires nanoscale separation to isolate the final active product."

At the research bench, many crucial experiments include high-resolution separations. As Wunsch notes, "A vast part of our understanding of biology has come from the ability to purify individual types of biomolecules so we can study their function." That's true of DNA, RNA, and beyond. The development of nanoscale materials, like carbon nanotubes, pushes the capabilities of separations to even finer levels.

Beyond scientific research and medical needs, some societal problems spur advances in these nanoscale separations. "Water stress pushes the need for more efficient reverse osmosis membranes, which exclude ions, meaning sub-1-nanometer," says Kemal Celebi, a research scientist in polymer chemistry at ETH Zurich (Switzerland). "Increased air pollution—for example, in Chinese cities—also requires more efficient particle filters."

SCIENCE OF SEPARATIONS

What really happens in a separation process? "All separation depends on creating an energy barrier that 'gates' the ability of a particle to move or locate somewhere in space," says Wunsch. Getting the gating right depends on some property of the particles, such as size.

▲ *A silicon wafer designed to sort particles found in bodily fluids for the purpose of early disease detection. (Image courtesy of IBM Research.)*

Filtration, for example, can provide nanoscale separation. Wunsch describes this basic approach: "You use a medium with small holes or pathways that only let particles that are smaller than the hole size through, while larger particles get stuck in the medium."

In many cases, separation gets interpreted as a mechanical process, like using filter paper in a basic chemistry lab, but molecular processes are also involved. To capture a specific protein from a blood sample, scientists can use molecules, such as antibodies, attached to a surface, like a glass slide. The binding molecule captures the targeted one, and everything else gets washed away. "This type of separation can be extremely efficient, as you can, in theory, pull out a single desired colloid from a complex mixture, but the difficulty is that you have to find or make the binding partner for your target colloid, and that can be complex and expensive, especially if you have to search through many candidates," Wunsch says.

The sample matrix impacts the method. For air, high-efficiency particulate air (HEPA) and ultra-low particulate air (ULPA) filters can remove submicron particles by absorbing them or excluding them based on size.

With liquid samples, on the other hand, scientists use different tools for nanoscale separations. "Liquid-based separations usually involve ceramic or polymer membranes that filter ions, small molecules, proteins, or viruses, usually by size-dependent exclusion," Celebi explains. "Particular nanotech-related improvements include antibacterial materials, such as silver nanoparticles, that prevent biofouling."

Nanowires and nanoparticles can be used in advanced polymers and ceramics to improve a membrane's performance by increasing its selectivity and durability.

Running a sample through a series of tiny channels, a field called microfluidics, is another means of separating components of a sample. "The aim here is to take advantage

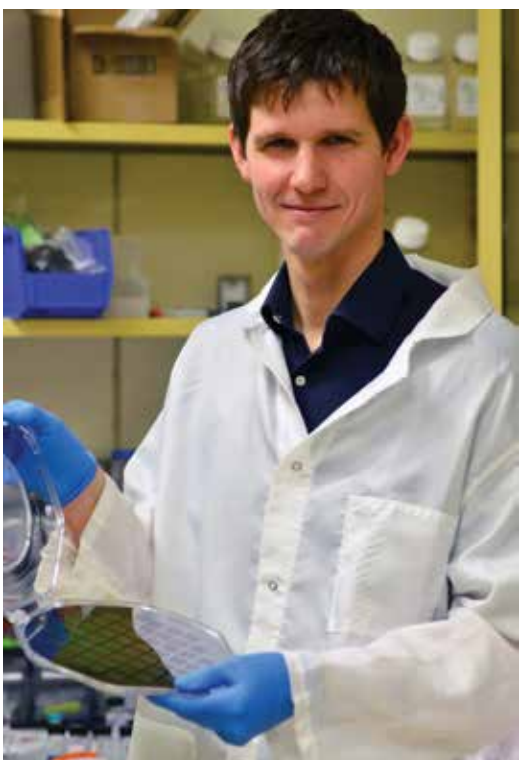
of micro and nanoscale properties to increase the effectiveness of nanoscale separation," Wunsch says. A series of separation techniques—including size-based, molecular mechanism, and more—can be performed on the same microfluidic chip. "With nanoscale engineering of separation systems, there is a real opportunity to achieve high precision by using well-defined structures that can interrogate individual particles, opening a new generation of separation capabilities," Wunsch concludes.

DOUBLING THE DIMENSIONS

Over the past decade, membranes have moved from one-dimensional elements, like carbon nanotubes, to two-dimensional forms of materials composed of graphene, polymers, and zeolites. "Such materials provide extreme thinness—which enables ultrafast transport, increasing the permeability and thus energy efficiency—while still remaining highly selective due to well-defined nanometer-size pore diameters," Celebi says.

Those advanced two-dimensional materials can be combined with polymers to make mixed-matrix membranes. With these, Celebi says, scientists can make "a new generation of cost-effective and scalable membranes."

▼ *Ben Wunsch of the nanobiotechnology team at IBM Research holding one of the silicon wafers. (Image courtesy of IBM Research.)*



FLOW IN A FOREST

In deterministic lateral displacement (DLD) technology, a sample goes through a "forest" of pillars. The arrangement of the pillars determines what can be separated and how. "By changing the way the pillars are lined up, you can deflect particles in different directions, and by changing the spacing between pillars, you can select out the size of particle you want to separate," Wunsch says. "It's a very flexible and versatile concept."

DLD separation also provides some valuable features, one being continuous operation. With a filter, for example, samples get separated in batches, but DLD can constantly separate samples. Furthermore, DLD can actually concentrate the separated product, which Wunsch notes is a very rare capability in purification technology.

Wunsch and his colleagues at IBM developed nanoDLD, which can separate particles down to 20 nanometers. "We've shown that you can achieve excellent resolution with biocolloids, such as DNA and lipid vesicles," he says.

A lot of innovation has taken scientists from paper filters to nanoDLD. The outcome is the ability to split samples into finer and more accurate collections of components, which has opened up new possibilities for industry, medicine, and research.

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

COUNTERING COUNTERFEIT PESTICIDES

ANALYTICAL METHODS HELP UNCOVER FAKE FORMULATIONS

by Angelo DePalma, PhD

Counterfeiting is a huge global problem affecting nearly every industry and product type.

In an analysis completed in 2016, the Organization for Economic Cooperation and Development (OECD; Paris, France) estimated that the worldwide impact of counterfeit, adulterated, and pirated goods reached $461 billion in 2013. Countries hardest hit by the global trade in bogus products were the United States ($20 billion), Italy ($15 billion), France and Switzerland ($12 billion each), and Japan and Germany ($8 billion each). The most egregious offenders by far were China (61 percent of all fakes) and Hong Kong (21 percent).

Because some studies include pirated entertainment and some do not, an Internet search will yield widely varying numbers for economic impact.

Irrespective of the tallying technique, counterfeiting is a big problem that affects end users and patent holders alike. The effects are mostly economic, but consider the potential consequences of taking a bogus medicine.

While counterfeiting and adulteration affect high-value products, most high-volume products of medium-to-low unit value are also susceptible. For example, the adulteration of honey, wine, and olive oil is common. Pesticides, which are middle-to-low value in terms of dollars per pound, nevertheless present a unique incentive for counterfeiting because of their extremely high-volume use.

DEFORMULATION

As expected, the trade in lower-cost fake pesticides is more prevalent in developing countries. Experts believe that in China and India, 30 percent and 20 percent, respectively, of pesticides applied to crops are counterfeit.

As with most formulated products, pesticide counterfeiting incorporates several strategies, each with unique downstream effects on the economy and public health.

All counterfeited pesticides negatively affect the bottom lines of manufacturers of genuine pesticide products through lost sales and negative brand exposure. The form that counterfeiting/adulteration takes determines secondary consequences.

Pesticides containing little or no active ingredient simply will not work, resulting in crop losses and potential shortages of some agricultural products. Substituting active ingredients is hit-and-miss, depending on the safety and effectiveness of the substituted ingredient: some replacements work, some do not; some are toxic to humans and the environment, some aren't.

Since repeat business is out of the question with ineffective or manifestly unsafe products, most pesticide counterfeiting takes a more subtle form.

The most effective counterfeiters duplicate the original product formula to the best of their ability—down to concentrations of actives and major excipients. Because analyzing for the active ingredient tells little about such products, Avomeen Analytical Services (Ann Arbor, MI) applies reverse engineering or "deformulation" of suspicious pesticides, side by side against the genuine item.

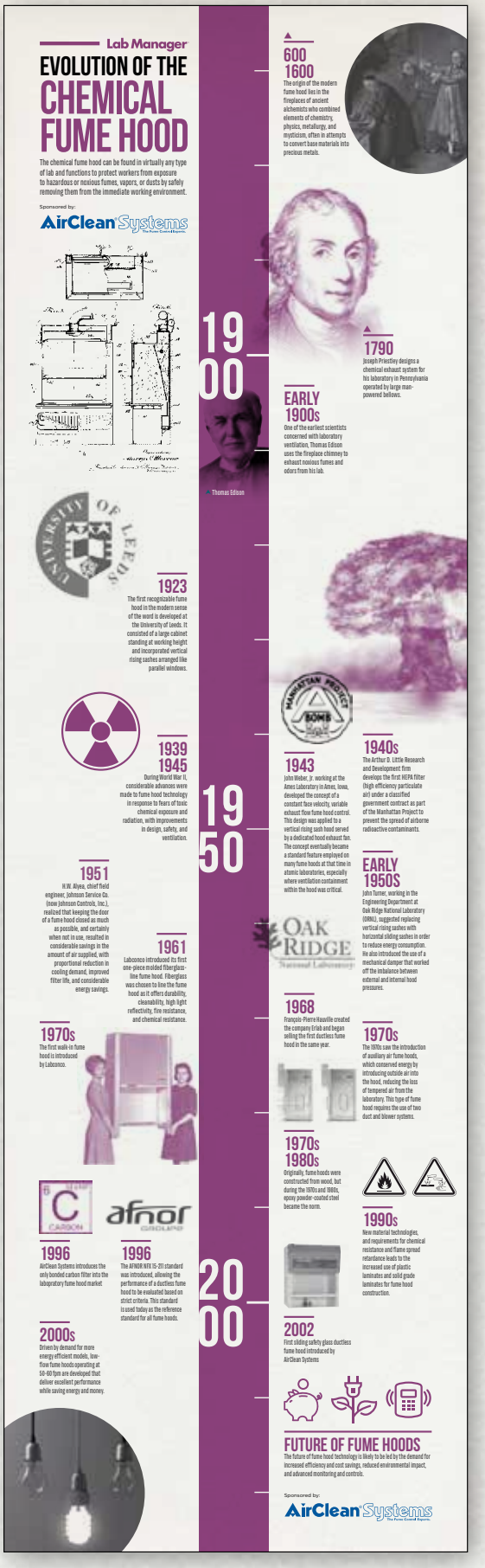
"From there, we develop test methods to determine if the product in question is counterfeit," says Andrew C. Kolbert, PhD, Avomeen's president and chief technology officer. One aspect of this exercise is to determine whether, by virtue of active constituents and formulation, a legitimate manufacturer has infringed on another's intellectual property.

WHY DEFORMULATE WHEN SIMPLE ANALYSIS WILL DO?

"Anyone producing counterfeit pesticides knows what's in the original or patented product," Kolbert tells *Lab Manager*. "From the user's perspective, if it's the wrong concentration of active, it's easy to test. If it's not right, you can quantify it. That's not a very subtle way to cheat customers. You have to look for the components that the counterfeiters left out or didn't think of, even though the active and excipients are the same."

But what if the faux formulator is really, really good and the product is exactly the same?

According to Kolbert, that is virtually impossible. "Genuine and counterfeit pesticides will never be the same. The originator is not required to list how much of every excipient is in there. Nor are all processing chemicals and machines exactly the same. The rubber and plastics that products come into contact with in plant A are not the same as in plant B. There are always markers unique to the legitimate product that are impossible to duplicate."



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In fact, patent holders will often add trace markers that do not show up on the product label or its registration forms. These are extremely difficult for a counterfeiter to duplicate but the original manufacturer knows where and how to look for them.

AN EU ISSUE?

If literature reports are any indication, counterfeit pesticides are a greater problem in the European Union than in North America.

The European Union Intellectual Property Office (EUIPO) recently released a report indicating that fake pesticides are responsible for losses of $1.4 billion per year, equaling the loss of 14 percent of legitimate revenue from bona fide pesticides, and the loss of approximately 2,600 jobs in the European pesticides industry. Small- to medium-sized manufacturers, which do about 40 percent of the business in pesticides, are particularly hard hit.

"If the knock-off effects on other industries and on government revenue are added, when both the direct and indirect effects are considered, counterfeiting in this sector causes approximately €2.8 billion [about $3.3 billion] of lost sales to the EU economy," according to the report.

There is also the cost of damaged brands, which is difficult to quantify.

Germany uses about 95,000 tons of agricultural pesticides, containing 32,000 tons of active substances, yearly. In Germany, pesticides undergo a license authorization procedure, and are monitored post-marketing to assure that product compositions correspond with the formulas under which their usage, or that of parallel products, was authorized. These formulas are called specifications.

In the EU, products with the same specifications (i.e., composition) as registered products may be imported from other member states without additional registration, but their identity must be established—first through paper documentation, and then if a doubt exists, by analysis.

Identity confirmation occurs at several levels, which include analytical methods. Tests include concentrations of actives and other ingredients, determination of physical and chemical properties, and impurity analysis. Testing uncovers counterfeit formulations, unauthorized or improperly labeled generic products, and batches that no longer correspond with licensing authorizations.

The specifications for genuine pesticides are established through regulatory filings, which impose tight constraints on concentration ranges for critical ingredients, excipients, and impurities.

Primary identifying criteria include appearance, density, and emulsifying behavior; irregularities are grounds for a determination of nonidentity, as are deviations from secondary criteria, such as pH, flashpoint, persistent foaming, and surface tension.

Active substances are the most critical pesticide ingredient, but tolerable deviations between declared and active substance content for plant pesticides vary according to product homogeneity and advertised concentration range. A five percent deviation is generally acceptable.

For pesticides, GC-MS or LC-MS are the analytical methods of choice, but other methods may be employed individually, for example, in particle-size analysis. In Germany, about 20 percent of pesticides with volatile components are analyzed by GC-MS. LC-MS handles the remainder.

While protocols and practices may differ between state regulators and private companies, the methods and approaches are similar.

For example, the order of primary or secondary criterion analysis is not set in stone. "Which tests occur depends on the level of suspicion for a product," says Martin Feyerabend, PhD, president of Eurofins Agroscience Services (Lancaster, PA).

"Authorities in Germany test more or less randomly. However, primary producers may have a more concrete basis for suspicion of counterfeiting, and will know better what parameters to look for."

Eurofins performs both general surveillance testing and analysis when fraud is suspected.

"In the latter case, we consult with the client on a testing regime, for example, analyzing the sample against the actual product specification. For random sample screening, we and the client agree on a stepwise, tiered analytical approach."

PROACTIVE VS. REACTIVE

Analytical techniques for detecting and identifying counterfeit pesticides all suffer from the drawback of being reactive. In the best-case scenario, red flags go up at the distributor level, before serious damage is done. In the worst case, the genie is out of the bottle: the shipment is completed, the purchase order is fulfilled, money has changed hands, and in some cases the counterfeit material has entered the food chain and the environment.

Many counterfeiting-prone industries therefore turn to track-and-trace options to reduce the potential for fraud at the earliest stages. Track and trace requires a level of cooperation between the manufacturer and user, but it alerts stakeholders to the likelihood of monkey business before events occur that are difficult to retract.

For example, the Verify Platform from Verify Brand (Minneapolis, MN) uses secure unique identifiers (sUIDs) and product traceability features for complete chain-of-custody tracking, creating a secure audit trail and alert system from the point of production to end-user delivery through web-based reporting tools. A secure website and mobile apps provide access to real-time data and analytics. As such, track and trace could be viewed as the first line of defense against counterfeiting, or even a front end for analytical methods. Codes may be redeemed once, or authenticated in accordance with predefined rules to allow checking a parent-level container or child-level unit package at various points within the supply chain.

Track and trace involves authenticating a machine-generated identifying code on product labeling or packaging against entries in a database. Multiple security features such as tamper-evident seals, holograms, and unique identifiers, in the form of human-readable alphanumerics, barcodes, nearfield, or RFID, may be combined to provide a higher level of assurance.

Verify Brand has worked with large chemical and pesticide manufacturers, as well as producers of high-end alcoholic beverages. Because brands typically don't broadcast their anticounterfeiting efforts, so as not to tip off counterfeiters, manufacturers are hesitant to discuss the details of their brand-protection programs or allow the brand's name to be used in case studies, says Curt Tomhave, senior VP for professional services at Verify Brand. "The last thing they want is to publicize their anticounterfeiting tactics. For that reason, it has been difficult to provide specific proof of success, which can make demonstrating the value of brand-protection software challenging."

Tomhave notes that whereas analytical methods are covert and require lab analysis, digital authentication and track and trace are overt and based on communicating with the end user. "While digital authentication and track and trace may not guarantee beyond a shadow of a doubt that the product attached to the unique identifier is genuine, it gives the consumer greatly increased confidence that the product is authentic, and provides the brand owner with tools to investigate an illegitimate source."

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Daniel W. Armstrong

ASK THE EXPERT

THE LATEST TRENDS IN CHIRAL SEPARATIONS

by Rachel Muenz

Daniel W. Armstrong is the Robert A. Welch Professor of Chemistry at the University of Texas at Arlington. He received his BS (1972) from Washington and Lee University and his MS (1974) and PhD degrees (1977) from Texas A&M University. He has nearly 700 publications, including 29 book chapters, one book (*Use of Ordered Media in Chemical Separations*), and 30 patents. He is considered the father of pseudophase (micelle and cyclodextrin-based) separations.

Q: What does your laboratory do?

A: We're a big lab, varying between about 20-30 people, and we do research in a lot of different areas—for example, in ionic liquids and, obviously, enantiomeric separations. Broadly speaking, we look at new materials for separations. We also do work in mass spectrometry and in the theory and mechanism of separations. The nice thing about having multiple people in multiple areas is you find that one occasionally overlaps with the other or you can apply something you learned in one area to one of the other areas.

Q: What do you use chiral separations for in your work?

A: We're the ones who design and develop/invent new chiral phases and new chiral separations materials and techniques, and we do it for HPLC [high-performance liquid chromatography], GC [gas chromatography], and even for capillary electrophoresis. We spend a lot of time trying to figure out how and why [chiral separations] work for some things and not for others. Once we develop these [methods], some of them are commercialized, and we'll then use them for cutting-edge research in many areas. For example, we've looked a lot at brain and biological D-amino acids analysis, which appear to be of great importance. We also separate new synthetic molecules, so we work a lot with synthetic organic chemists and we use our methods for distinguishing synthetic products from natural products.

Also, we're always interested in any difficult achiral separations. It has been found that there are many non-chiral or achiral separations that are best done with chiral stationary phases. We pushed this long ago, but the pharmaceutical companies are picking up on it now. Things like peptides are difficult to separate and often separate better on chiral phases even if they're not enantiomers.

Q: What are some of the other recent trends in chiral separations?

A: Traditionally, chiral separations have been all about selectivity. Selectivity was all-important and it had to be, because if you didn't have selectivity, nothing was going to work. Now we've evolved past selectivity into ultra-high efficiency, particularly as it relates to doing ultra-fast separations. We published one paper and we're about to publish a few more, where we're doing chiral separations in under a second and we have up to two pairs of enantiomers in less than a second. Why, you might ask, do we want go ultra-fast for chiral and non-chiral separations? Well, this is for a variety of reasons. Our focus is going to be doing chromatography at sensor speeds. Sensors have the advantage of being relatively fast—a few seconds or sometimes less than a second—but they have many shortcomings. They're usually only good for measuring one thing; if you change the matrix or there are any interferences, it doesn't work, whereas chromatography has the advantage that it separates the matrix and you can do multiple things, but it takes longer to do. So, what we're focusing on is bringing chromatography to sensor speeds. I think it will be a pretty high-impact area. Recently, we've been able to separate 10 peaks in under one second.

Q: What are some of the most exciting new applications for chiral separations?

A: They're going to play a major role in comprehensive two-dimensional separations. I think chiral phases are going to be used not just for chiral molecules but also for non-chiral, difficult separations. We're pretty much there [with faster second-dimension speeds]. One problem is that the hardware (the chromatographs) must be improved in order to take full advantage of these new columns. Also, high-throughput screening is becoming more and more important. It has always been important in industrial labs, and it's going to become more important even in academic labs. [Another application is] doing

biological samples, not just synthetic molecules, but [looking at the] biological consequences of chirality.

Q: What are some of the key challenges you run into with chiral separations in your work?

A: One of the main ones we have in my lab is having enough HPLCs to go around. Going ultra-fast helps with that a little bit. For example, we were doing some biological amino acid work in brain studies, and the first one we did took us a year and a half to do all the analysis. There were thousands of separations we had to do, but a year and half to grind out that data was just too long. Now we can do the same amount of work with our new approaches in a few days or a few weeks, so that makes a huge difference.

Q: How did you achieve those faster speeds?

A: That came from combining chiral techniques with mass spec and the multi-dimensional chiral techniques with mass spec. Using the right combination of all of those really speeded things up for us and made all the projects more feasible. The gain in efficiency and the ability to get data out in a reasonable time and spend more time interpreting it and then designing further experiments—that's all becoming far more reasonable. If we had to spend a year and a half generating data for every study, it would just be interminably long and inefficient.

Q: What advice do you have for those who are new to chiral separations?

A: First of all, there are a lot of different chiral phases out there. Whichever chiral phase you're using, [vendors] want you to use their specific mobile phase. But you can't use one company or one type of mobile phase [designed] for one type of column for other types of columns. The companies will try to get you to do that because it works for their column and not for the other [company's] column, so their column always looks better. [Researchers] need to understand that. They need to use the optimum separation conditions for each chiral stationary phase. Using a mobile phase for one type or class of column for another can give you bad results.

Chiral phases are also more selective and sensitive to the nature of the mobile phase and the additives in the mobile phase, and this is true not only for HPLC but also supercritical fluid chromatography (SFC), which is widely used in chiral separations. The additives you use for one type of column in SFC could be additives that totally kill the separation with another type of column. You have to be really careful about that and think about what you're doing. It's harder to cookbook it or just use a standard set of techniques like people are used to doing with typical achiral separations—C18 separations, for example.

> "As you get to fast higher-efficiency separations, the equipment needs to change and evolve."

Q: What are some of the most exciting technologies you've seen coming out?

A: What's coming in chiral separations now are the new higher-efficiency particles, particularly the superficially porous particles, or the so-called core-shell particles; these are going to be a real game-changer. You're going to be doing separations in a third of the time, have about three or four times the number of theoretical plates, and be able to use a shorter column. These are the particles that are spurring the ultra-fast separations and the ultra-high-efficiency separations that everyone's going to be doing. I think the classic 25 cm long, 0.46 cm diameter column is going to become extinct. I can tell you that when my students use the new columns and you try to take them away and give them the old column back, they don't want to do it. They want to keep the new columns because they're just so much faster and so much more efficient. It's easier to quantitate peak areas and saves time.

Q: Where do you see chiral separations going even further into the future?

A: Chiral will always have the chromatographic advantage—because enantiomers have the same mass, you can't tell them apart easily by mass spectrometry or anything like that, so you're always going to need chiral separations even far into the future. As far as instrumentation, I think as you get to fast higher-efficiency separations, the equipment needs to change and evolve. Even UHPLCs aren't good enough for these typical high-efficiency separations. Even for an advanced UHPLC, the detector speeds need to be faster, the dead volume needs to be smaller, the pumping and the flow rates have to be higher, and they have to be able to take a higher back pressure. The columns have evolved faster than the instrumentation. The instrumentation has to keep up and so there's always that challenge.

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CHROMATOGRAPHY DATA SYSTEMS

IT TAKES A DATA SYSTEM TO STAY IN CHARGE

by Mike May, PhD

The days of dealing with chromatography data by hand, or even with systems dedicated to single instruments, disappeared long ago (or at least they should have). Every lab that uses these separatory techniques needs a chromatography data system (CDS), which enables scientists to run various chromatography platforms, capture and analyze the results, and produce a report. Doing all that, without a degree in computer science or instrumentation, demands that a CDS be easy to learn and use.

At UK-based Sterling Pharma Solutions, scientists use high-performance liquid chromatography (HPLC), ultra-HPLC, ion chromatography, and more. In fact, this lab connects dozens of chromatographs to one CDS. As explained by Brian Alliston, data integrity expert and CDS specialist at Sterling Labs, "We analyze raw materials to final products, and that involves processing samples, validation, and method development." This work includes about 8,000 chromatography injections per month.

The systems come from different vendors, including Agilent (Santa Clara, CA) and Thermo Fisher Scientific (Waltham, MA). But an advanced CDS can handle all that. "One big thing," Alliston says, "is that we can get all of our chromatography data on one open system."

Today's researchers have a range of CDS options, including Thermo Fisher Scientific's Chromeleon, Agilent's OpenLAB, and numerous others.

Interface appeal

We live in a world of user interfaces, from ATMs and smartphones to televisions and tablets. With more exposure to such systems, a user expects certain attributes. "Scientists look for user interfaces that are similar to those found in general business applications, such as Microsoft Office," says Linda Doherty, senior manager of product marketing for software and informatics at Agilent Technologies. "Our studies have shown that the older, menu-based user interfaces are more difficult to navigate, and lab analysts and technicians—more familiar with smartphone applications—expect a user interface that guides the analyst through tasks without words and menus." Even a pull-down menu can be too much trouble to navigate for some scientists.

"Scientists look for user interfaces that are similar to those found in general business applications, such as Microsoft Office."

The similarity between the interface with a smartphone and a CDS goes one step further: Scientists often seek a mobile-app option for their CDS. That, says Doherty, should provide "a responsive interface to easily check on samples and instrument status remotely." In the past, Alliston and his colleagues at Sterling used two CDSs located in different buildings. "When we switched to Thermo Fisher's Chromeleon," Alliston explains, "we needed just one system." Chromeleon provides centralized control, enabling scientists to keep an eye on all the chromatography platforms from the same place.

Running multiple instruments in various locations from one CDS offers the benefit of keeping a company's data in one spot. This centralized data storage allows for better organization with possibilities for archiving and disaster recovery" says Barbara van Cann, product specialist for chromatography software at Thermo Fisher Scientific.

A modern CDS interface should not only be easy to use, but also simple to learn. Alliston says, "In training new staff, you want the software to be easy and intuitive, so they pick it up quite easily and have a shortened learning curve." He adds that a good CDS should "just flow, so that someone could have a good stab at getting something done on it even without training."

Still, a good CDS comes with training tools. "User assistance tools must be readily available, not just online help, but tutorials and videos," Doherty says.

Output options

With a CDS, collecting the data is important, but what scientists can do with that data also matters. "A big thing for our interface is reporting," Alliston says. "You can do any calculation that you want."

The data in a CDS can be mined through queries. For example, a scientist can collect all the data for injections on a particular day or by a specific person. "This also lets you do stability analysis," Alliston says. "We can look at data on a type of injection across months, and put it all in a report without needing something like Excel."

"A modern CDS interface should not only be easy to use, but also simple to learn."

Certain CDS features can also help researchers meet regulatory requirements. "Regulatory authorities make it a requirement to review the audit trail of data," Alliston says. "With our CDS, the audit trail is really easy to look at." That's not always the case, because he points out that the audit trail can be hard to find and difficult to interpret in some chromatography software. For anyone planning to use a CDS on research that is regulated, it's worth finding a product that helps a company see what happened all along a data trail and why.

Sterling Pharma Solutions produces active pharmaceutical ingredients (APIs) for multinational companies as well as for tiny ones. Some of those APIs go to research and others go into pills on the market. Sterling also sells APIs to pharmaceutical companies in the European, Japanese, and U.S. markets. That means that its CDS interface must accommodate a variety of expectations, such as nuances in regulatory rules from different agencies.

To make it easier to provide what regulators need, van Cann points out that a CDS can offer features such as electronic signatures and built-in instrument and software qualification.

Which features matter the most depends on the way in which a CDS will be used. For any application, though, scientists should expect a robust and intuitive interface.

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FOR ADDITIONAL RESOURCES ON CHROMATOGRAPHY DATA SYSTEMS, INCLUDING USEFUL ARTICLES AND A LIST OF MANUFACTURERS, VISIT WWW.LABMANAGER.COM/CDS

WHAT DO MASS SPECTROMETER USERS HAVE TO SAY?

Mass spectrometers, measuring the mass-to-charge ratio of charged particles to determine their molecular weight, have not quite become a routine acquisition for every lab that might benefit from them. Four parts are standard in all mass spectrometers: a sample inlet, an ionization source, a mass analyzer, and an ion detector.

Sample types analyzed by survey respondents:

Blood, body fluids, and cultures	32%
Drinking water	26%
Human blood and body fluids	26%
Animal tissue	25%
Pharmaceuticals	25%
Food and food related products	22%
Waste water	21%
Soils	19%
Air	17%
Clinical samples	17%
Plants	17%
Polymers	15%
Petroleum and related products	13%
Gases	12%
Metals	10%
Oils	10%
Rocks and minerals	10%
Controlled substances/narcotics	6%
Cosmetics	6%

Some of the most exciting applications of mass spectrometry, as reported by survey respondents:

- Metabolomics
- Structure elucidation
- SIMS analysis
- Intact protein analysis
- Aerosol chemistry
- Forensic analysis of contaminated currency
- PK analysis

TOP 6 QUESTIONS

You Should Ask When Buying a Mass Spectrometer

1. What factors come into play when determining the MS specifications you require in terms of throughput, sensitivity, robustness, software control, ease of use, and ease of maintenance?
2. What differentiates the vendor's MS from others offered, in terms of performance and how easy it would be to upgrade?
3. How do you validate the specification claims presented by the vendor?
4. Has the data processing software been designed for enhanced analytics, with lab workflow in mind and does it support critical compliance requirements?
5. What are important price points to keep in mind when selecting an MS?
6. Laboratories need fast and effective services, including an effective distribution of spare parts, instruments, service personnel, and education/ training. How does the company serve these needs globally?

PRIMARY APPLICATIONS

for mass spectrometer use as reported by survey respondents:

TEST WATER QUALITY OR FOOD CONTAMINATION	32%
DETERMINE STRUCTURES OF DRUGS AND METABOLITES	30%
OTHER	30%
QUANTITATE (RELATIVE OR ABSOLUTE) PROTEINS IN A GIVEN SAMPLE	26%
DETERMINE PROTEIN STRUCTURE, FUNCTION, FOLDING, AND INTERACTIONS	21%
SCREEN FOR METABOLITES IN BIOLOGICAL SYSTEMS	20%
DETECT DISEASE BIOMARKERS	16%
DETECT SPECIFIC POST-TRANSLATIONAL MODIFICATIONS THROUGHOUT COMPLEX BIOLOGICAL MIXTURES	14%
PERFORM FORENSIC ANALYSES	12%
SEQUENCE OLIGONUCLEOTIDES	3%

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

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Christoph Bock, PhD

ASK THE EXPERT

ADVANCES IN GENOMICS TOOLS

by Tanuja Koppal, PhD

Christoph Bock, PhD, a principal investigator at the CeMM Research Center for Molecular Medicine in Vienna, Austria, talks to contributing editor Tanuja Koppal, PhD, about the new CROP-seq technology for single-cell CRISPR sequencing that his group has developed and its potential uses for functional screening. He talks about some of the inherent challenges working with CRISPR and other phenotypic screens and how some of this can be overcome with new approaches like CROP-seq.

Q: Can you share with our readers the recent advances in Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) screening and some new applications that are being developed?

A: CRISPR technology has revolutionized the way scientists investigate the biological function of genes. It is now possible to edit or delete genes much faster and more efficiently with CRISPR than with any alternative technology. In fact, the method works so well that it is possible to add CRISPR guide-RNAs (i.e., the short RNAs that direct the CRISPR/Cas9 genome editing to specific genes) against thousands of genes to a large pool of cells, and use Darwinian selection to find those guide-RNAs that target genes that make the cells grow faster or slower, or affect their susceptibility to a drug. This approach is called pooled CRISPR screening. Typically, you first infect a large number of cells with guide-RNAs that target many (or all) genes in the genome. Then you apply the drug or the virus, wait until the nonresistant cells die, and you sequence the guide-RNAs of the surviving cells. Pooled CRISPR screening effectively pinpoints genes involved in the cell's sensitivity to a drug or a virus.

However, this approach does not work so well when the phenotype of interest is more complex than just counting surviving cells. In biomedical research, you may, for example, be interested in upregulation of a key cancer pathway, dedifferentiation to a more immature state, or metastatic potential. These cellular phenotypes are not readily accessible to classical CRISPR screens, but they can be inferred from a cell's transcriptome. This is why we developed the CRISPR Droplet Sequencing (CROP-seq) method for pooled CRISPR screening with single-cell transcriptome readout. In other words, for each guide-RNA, we can measure how the inactivation of its target gene influences the transcription of other genes in the genome, which is highly informative for understanding the biological function of the target gene. Importantly, with CROP-seq, this can be done in high throughput, studying thousands of genes and hundreds of thousands of cells in parallel.

Q: Can you explain how CROP-seq works and elaborate on some of its inherent limitations, as well as its promise?

A: When we study the behavior of cells, transcriptome profiling by RNA-seq is by far the most informative assay—it gives us the expression levels of thousands of genes and a deep insight into the biology of the cells under investigation. However, combining CRISPR genome editing with RNA-seq was labor-intensive and low-throughput because you need a separate cell culture dish (or a well on a 96-well plate) for each gene that is being investigated, in order to keep the cells that are infected with different guide-RNAs separated from each other. The fundamental idea behind CROP-seq and single-cell CRISPR sequencing is that this separation is no longer necessary when performing single-cell RNA-seq—in this case, the cell membrane of each individual cell provides the separation between different guide-RNAs and the changes in gene expression that are caused by the deletion of each targeted gene.

Exploiting this novel combination of CRISPR genome editing and single-cell sequencing technology, CROP-seq (http://www.nature.com/nmeth/journal/v14/n3/full/nmeth.4177.html) makes it possible to perform a CRISPR screen for anything that can be inferred from the transcriptome. For example, there are gene signatures for the activity of signaling pathways, metabolic states, drug resistance, and many other aspects of cell biology. Indeed, if you ask scientists, "Assume that there's only one assay that you could run on your cells, what would give you the most information?" I think most will go for transcriptome profiling/RNA-seq as their first choice. Using CROP-seq, we can search for genes involved in cancer pathways, dedifferentiation, and metastatic potential—or anything else

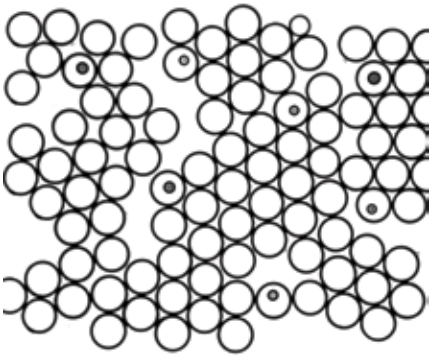
that is reflected in the transcriptome of the cell. An additional advantage is that you do not need to know upfront what you are looking for. Based on the same CROP-seq dataset, you can run screens for many different pathway signatures purely on the computer.

Practically speaking, a CROP-seq screen works as follows:

1. Select an interesting cellular model (e.g., a cell line in which you induce or knock down a cancer gene).
2. Design a guide-RNA library for genes of interest (our recent paper showed a proof-of-concept with more than 100 guide-RNAs, but CROP-seq is limited only by the cost of single-cell RNA-seq, and libraries targeting thousands of genes are entirely feasible and increasingly affordable).
3. Take the cells, infect them with the guide-RNA library, and induce any biological stimulus that may be of interest (e.g., treatment with a drug or infection with a pathogen).
4. Perform single-cell RNA-seq before and after applying the stimulus.
5. Perform bioinformatic analysis to link guide-RNA target genes to their transcriptome responses.

As its main result, CROP-seq provides a comprehensive assessment of genes involved in the molecular mechanism of interest and a bioinformatic model of the underlying regulatory dynamics. It moves much of the biological discovery into the computational analysis of large CROP-seq datasets, which can lead to a substantial speed-up for biomedical research and functional dissection of gene-regulatory mechanisms.

Q: How does your recent work in developing CROP-seq help with driving the field forward in terms of serving new applications and industries?



▲ *CROP-seq in Action*
This image shows genome-edited cells lysed in tiny droplets, ready for single-cell sequencing. By combining CRISPR genome editing with single-cell sequencing, CROP-seq provides a powerful new paradigm for high-throughput functional studies and complex phenotypic screens.
(Source: Dr. Christoph Bock)

A: It will be very exciting to apply CROP-seq technology to complex and heterogeneous tissue, including primary tumors where each cell type may respond differently to a drug administered to the tumor as a whole. Led by my CeMM colleague Stefan Kubicek, we have previously shown that single-cell RNA-seq can be used to investigate cell-type specific response to drugs directly in primary human tissue (human pancreatic islets treated with an anti-malaria drug to induce insulin production, recently published in Cell: http://www.cell.com/cell/comments/S0092-8674(16)31531-8). With CROP-seq, we can now test whether different cell types within the same tumor depend on different genes in the way they handle, for example, the challenges of chemotherapy. More generally, given that CRISPR screens have become the method of choice for discovering new biology in a broad range of diseases and other applications, CROP-seq has huge potential to add deep regulatory information to any CRISPR screen, shortcutting much of the—typically laborious and time-consuming—validation and functional workup that follows a classical CRISPR screen focusing on cell survival.

Q: What would you advise researchers looking to invest in new CRISPR and genomic technologies?

A: Just give it a try—we have published a detailed open-source protocol for CROP-seq on the website (http://crop-seq.computational-epigenetics.org/) and the plasmid is available via AddGene (https://www.addgene.org/86708/). Indeed, approximately 100 laboratories from a broad range of fields have already obtained the CROP-seq plasmid and are currently exploring how CROP-seq can advance their research.

Christoph Bock is a principal investigator at the CeMM Research Center for Molecular Medicine of the Austrian Academy of Sciences. His research focuses on dissecting the role of epigenetics in cancer and on developing high-throughput technologies for precision medicine. He is also a guest professor at the Medical University of Vienna, scientific coordinator of the Biomedical Sequencing Facility at CeMM, and adjunct group leader for bioinformatics at the Max Planck Institute for Informatics. He has received several research awards, including the Max Planck Society's Otto Hahn Medal (2009), an ERC Starting Grant (2016-2021), and the Overton Prize of the International Society of Computational Biology (2017).

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PCR

SHORT TANDEM REPEATS TO THE RESCUE

by Angelo DePalma, PhD

Much has been written recently about "fake news," and sadly big science is faced with its own brand of fakeness. Estimates of irreproducibility in published scientific studies—"fake science," if you will—ranges from about 50 percent to 90 percent. Writing in *PLOS Biology* (https://goo.gl/YND38N), Leonard Freedman, PhD, president of the Global Biological Standards Institute (Washington, DC), estimated that U.S. research institutions waste $28 billion per year on nonreproducible preclinical research, with the total reaching $60 billion worldwide.

Irreproducibility results from cumulative errors associated with biological reagents, reference materials, study designs, laboratory protocols, and data analysis.

"There is no single magic bullet fix for this situation," Freedman tells *Lab Manager*, adding that scientists must "own up" to the problem.

Misidentified and contaminated cell lines contribute significantly to irreproducible science. For decades, scientists relied on immortalized cancer cell lines for cell-based tests of drugs and other substances. As these cell lines expand and grow through succeeding generations, many undergo spontaneous genetic changes that affect their consistency and reproducibility. Sharing of cell lines among labs is widespread. "Contamination and misidentification errors therefore occur frequently, and persist for years or decades," Freedman laments.

Thus, more than one-third of research lines are contaminated or misidentified or overgrown with other cells. Whenever a rapidly dividing line finds its way into a slow-growing culture it takes just a few weeks to completely overcome the "advertised" cells.

Freedman argues that despite the varied contributions to irreproducibility from factors that are difficult to control, cell line authentication (CLA) is a relatively easy, inexpensive operation that assures, with high confidence, that the cells a researcher believes she is working with are actually those cells.

The analysis of short tandem repeats (STRs)—also called short polymorphic DNA sequences or DNA microsatellites—has become the method of choice for human cell line authentication. The technique, commonly known as DNA fingerprinting, was borrowed from forensics. Its low cost, precision, and ease of execution makes it ideal for guaranteeing the authenticity of human research cells.

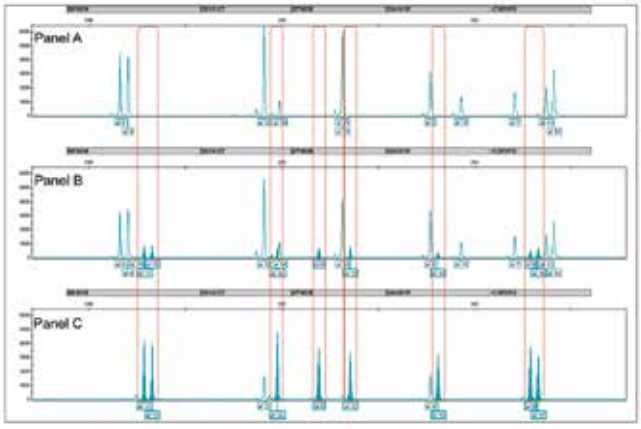
STR analysis examines the number and repeat frequency of between two and seven base pair units, which occur up to about a dozen times in one locus and signify a cell line's uniqueness. The sequences are compared against database entries to identify individuals or phenotypes.

STR analysis is available commercially only for human cell lines because that is the only reference database that exists. "But in principle you could check authenticity over many generations for any cell type by creating your own database," Freedman adds.

It is an easy analysis to run, but with the cost so low it does not make sense for most labs to gear up to run their own STR assays, and makes even less sense for older techniques like isoenzymology, karyotyping, and cytogenetic analysis. Single-nucleotide polymorphism (SNP) analysis also works and may be even more precise than STR assays. "But there are no commercial services for SNP, and unless your lab is set up to do SNP you're probably better off sending samples out for STR," says Freedman. Whole genome sequencing is another technique that may find utility one day, but it cannot compete on the basis of cost with STR.

Greater statistical relevance

Many real and imagined shortcomings of conventional STR analysis may be overcome by analyzing more loci. In 2012, the American Tissue Culture Collection (ATCC) workgroup recommended using at least eight STR loci for CLA (https://goo.gl/JZR1M7), which STR reagent vendors follow. For example, Promega (Madison, WI) has long offered the GenePrint® 10 system, for ten loci. The company recently launched GenePrint® 24, specifically for mixed sample analysis. With 24 loci, the product offers significantly higher discrimination for authenticating a sample's identity.



▲ *Detection of contaminating HeLa cells in HEK293 culture using the GenePrint® 10 System. The GenePrint® 10 system is able to identify HeLa cell line contamination, a common and well-known source of contamination in many cell line cultures. Panel A: HEK293 genotyping profile at the D5S818, D13S317, D7S820, D16S539, and CSF1P0 loci. Panel B: Mixed genotyping profiles of HEK293 and HeLa, detecting that contamination is present. Panel C: HeLa genotyping profile at D5S818, D13S317, D7S820, D16S539, and CSF1P0 loci.*

With GenePrint 10, the likelihood of two individuals (excluding identical twins) having the same genotype is 2.9×10^{-9}. With GenePrint 24, the likelihood is 6.6×10^{-29}.

Doug Storts, PhD, head of research at Promega, notes that cultured human cells are typically unstable, as exemplified by changes in chromosome copy number (chromosome duplications and loss of heterozygosity) and other factors like small deletions, insertions, and point mutations. Cell line instability may lead to deletion/mutation events that cause loss of some of the STR markers, thereby lowering the probability of identity value. Higher numbers of markers increase the likelihood that you will uniquely identify the cell line despite the loss of markers.

"To accommodate this inherent instability, the standard recommendation allows variability at 20 percent of the alleles. For these reasons, and the increased number of new cell lines being derived, there is merit to achieving greater discrimination power by using a system with more loci," says Storts.

Alternatives

The pathway to novel, authenticated cell lines does not always go through STR, particularly when the purpose of authentication is to establish a new cell line. In late 2016, Cellaria (Cambridge, MA) introduced two new cell models for ovarian cancer and one for breast cancer. Both ovarian cancer lines were derived from patients—one with aggressive ovarian cancer, the other with endometrioid ovarian cancer.

Cellaria used SNP genotyping to evaluate the cells' genomic stability and concordance with up to 98% with the patients' tumors. With each batch of cells, Cellaria provides a certificate of analysis that includes the expected growth rate, clinical history, and quality-test results, including STR profiling for cell line authentication.

"With STR, you typically measure no more than 16 positions in the genome to achieve a unique combination or fingerprint," says David Deems, Cellaria's president. "We offer this test to our customers and use it ourselves for routine, lot-specific cell line authentication."

Compared with STR, SNP genotypes samples at a much higher density across the genome, in Cellaria's case at around 100,000 locations across the genome in the tumor sample, and again in the resulting cell line. "We used this approach to assess whether the cell lines exhibited the high degree of genomic instability that plagues many cells when passaged repeatedly in culture," says Deems. "While not 100 percent concordant, the high degree of concordance we see between the original tissue and the cell line demonstrates that our culture conditions are a step in the right direction. As a point of reference for this assay, identical twins have been reported as 99.98 percent concordant, whereas we have observed unrelated patient samples as low as 50 percent concordant."

Cellaria is currently employing even higher-resolution analysis to track specific mutations from the original tumor through the cell model derivation process.

Hope and change

Given the strong scientific justification and low cost, has the tide begun to turn from lackadaisical indifference to authenticating cells?

"Slowly, but I believe it is," says Freedman. "Funding agencies and journals increasingly require an authentication plan but it's not always completely clear what that involves. Researchers are more aware of the problem, and I've heard that companies providing STR-related services are doing well. But it's evolving more or less on the honor system."

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

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

WHAT DO BIOLOGICAL SAFETY CABINET USERS HAVE TO SAY?

Biological safety cabinets (BSCs) are enclosures that protect users and the environment from biohazards by removing particulates and aerosolized pathogens from the work area through HEPA filtration, then recirculate or exhaust the purified air, hence cleansing the workspace air.

Biological safety cabinet types used by survey respondents:

Class II Biological Safety Cabinet	82%
Class I Biological Safety Cabinet	26%
Class III Biological Safety Cabinet	12%
Other	2%

Application conducted in biological safety cabinets as reported by survey respondents:

Cell / tissue culture	48%
Microbiology plating / specimens	44%
PCR/qPCR	30%
Sample and reagent storage	30%
Pathogen handling	29%
Mycology	17%
Gross dissection	15%
Laboratory animal handling	9%
Other	6%

Of those respondents interested in purchasing a new biological safety cabinet, the reasons for these purchases are as follows:

Replacement of aging system	34%
Addition to existing systems, increase capacity	26%
Other	24%
Setting up a new lab	14%
First time purchase	2%

TOP 5 QUESTIONS

You Should Ask When Buying a Biological Safety Cabinet

1. Do the samples/specimens/cultures need to be protected from environmental particulates? Answering this question determines what type of BSC you require.
2. Are chemicals involved in your application? Hazardous (toxic or volatile) vapors are not filtered by the HEPA/ ULPA filters found in BSCs. Different BSC designs are available.
3. What are your size limits? Know what the maximum space allotment is so that you don't end up with equipment that is too big for your lab, or so small that you can't work.
4. Does your procedure require modifications to the equipment that are uncommon? BSCs should be built to an appropriate standard and listed by a testing agency. Some modifications can lead to the equipment being unsafe; reputable manufacturers will not provide such alterations.
5. Cost is always a concern. Avoid looking at the sticker price of a BSC; inquire instead about the lifetime cost of each BSC. This includes energy savings, service life, and a proven product track record.

TOP 10 FEATURES/FACTORS

Respondents Look for When Purchasing a Biological Safety Cabinet:

WARRANTIES	60%
VENDOR REPUTATION	41%
VALUE FOR PRICE PAID	72%
TOTAL COST OF OWNERSHIP	64%
SERVICE AND SUPPORT	74%
SAFETY AND HEALTH FEATURES	85%
PERFORMANCE OF PRODUCT	84%
PAST EXPERIENCE WITH PRODUCT	34%
LOW OPERATING COSTS	58%
CURRENTLY USING VENDOR'S PRODUCTS	23%

For more information on biological safety cabinets, visit www.labmanager.com/BSCs

GLASSWARE WASHERS

HOW TO WASH GLASSWARE RIGHT IN THE LAB

by Mike May, PhD

Years ago while helping a friend do the dishes by hand after dinner, my friend said, "There's something odd about how you do dishes. You're so careful." She was right. I do wash them thoroughly—I rinse them until there is no soap left on them, and then I dry them completely. Before I could reply about my technique, she said, "You do dishes like it's lab glassware!" She was right again. Despite washing plenty of dinner dishes, I've washed far more glassware in the lab, and that means following a key rule—for hand or machine washing: Do it carefully and completely.

Given all the automation in today's science, everyone uses only a machine to wash lab glassware, right? Not necessarily. Some scientists still wash some glassware—maybe not tons of it, but some—by hand. When asked for his top tip for hand washing glassware, Michael Moussourakis, director of technical marketing and commercial development at Alconox (White Plains, NY), says, "When cleaning manually, you can take advantage of higher-foaming detergents and mechanical energy—elbow grease, ultrasonics, etc.—which all greatly assist in residue removal."

Top tips

The right detergent makes all the difference in cleaning glassware. David Hayes, product manager for Cole-Parmer (Vernon Hills, IL), says, "Any nonabrasive glassware detergent can be used; however, we recommend ones designed for lab glassware as they are preferable to those used at home." For machine washing, the detergent should be low-foaming.

How glassware is loaded into the machine matters as well. Moussourakis says that it should be arranged to "minimize trapping any water from cycle to cycle." As he points out, "Often by appropriately tilting vials, glassware, and equipment, they can be oriented to drain completely and not trap dirty wash solution."

Clean and green

Some labs, especially industrial ones, clean lots of glassware. In those cases, neglecting energy efficiency should be a crime. In fact, any lab that washes glassware—and that is almost every one of them—should keep efficiency in mind in any lab process. Despite the fact that some political leaders don't believe in climate change, scientists should still behave in ways that reduce our effect on it. When buying a new glassware washer, get an efficient one. Price always matters, but spend as much as necessary to get a machine that is efficient.

Like other equipment in a lab, proper washing procedures improve efficiency. "Selecting the right detergent for the right residue makes repeated washing unnecessary," says Moussourakis. "Further, use high-quality detergents that do not need high concentrations or harsh chemicals to be effective."

So, better equipment ensures greener washing, and better practices and cleaning products can too. Let's do our part to show that scientists walk the cleaner walk—in glassware and environmental matters.

Get to it

Beyond what is used—hands or machine—and which detergent, when the washing gets done matters too. "Wash as soon as possible after use," Hayes says. "The longer glassware stands, the harder it may be to clean."

Given that this article started by hand, it can end there. With manual cleaning, glassware pros often use a brush, but it should have soft bristles that don't damage the surface of the glassware.

That's it for now. I'm heading back to the sink.

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

FOR ADDITIONAL RESOURCES ON GLASSWARE WASHERS, INCLUDING USEFUL ARTICLES AND A LIST OF MANUFACTURERS, VISIT WWW.LABMANAGER.COM/LAB-WASHERS

LAB OVENS

KEY FEATURES TO AVOID FIRES AND FUMES IN THE LAB

by Erica Tennenhouse, PhD

Ovens are essential components of most labs, and can be used in a variety of processes including drying glassware, drying samples, melting, and chemical reactions. But with the many potential dangers that come with the use of lab ovens, users must always remember to put safety first.

What is the single greatest risk associated with lab ovens? "Humans," says Uwe Ross, president of BINDER, Inc. (Bohemia, NY). "I think the danger of getting hurt comes when people don't understand what they are touching. And one of the biggest safety features of the lab oven is actually to read the user manual."

Beyond reading the manual, there are certain considerations when it comes to lab ovens that can vastly improve safety. Eric Stimac, general manager of Jeio Tech, Inc. (Billerica, MA), says that for one thing, customers should look for products with safety certifications such as COL or UL.

Customers can usually opt to receive automatic warnings that let them know what their oven is doing. Visual and audible alarms are added features that will tell the user whether the fan in a convection oven has turned off, whether the door has been open for a certain amount of time, or whether the temperature has gone higher than a specified value, says Stimac.

However, to ensure that temperatures are kept within a certain range, both Uwe and Stimac agree that independent temperature safety devices are a step up from alarms. These are essentially temperature fuses that either cut the power at a fixed temperature, or can be programmed to shut the oven down at a specified temperature.

Still, Uwe notes that something as simple as a door that automatically locks when the internal temperature is above a certain point, and can only be opened once it cools off, can make a big difference in terms of user safety.

Perhaps a less obvious feature, but one that should still be considered, is insulation, says Uwe. "The insulation of some laboratory ovens is good enough to ensure that the product, even at the maximum temperature on the inside, is safe to touch on the outside."

Users should also think about what types of materials are going into their ovens. "When you have flammable solvents or combustible material," says Uwe, "you should not operate in a regular laboratory oven to begin with." For this situation, there is a range of specialty ovens to pick from, the most basic one being a vacuum oven.

> "Users should also think about what types of materials are going into their ovens."

Even in a vacuum oven, Stimac advises users working with organic solvents to exercise caution. "A small quantity of organic solvents is OK to use, but the vacuum oven would need to have accessory safety options put onto it," he says. Also, connecting chemical-based ovens to a duct system can help prevent fumes from blowing into the lab.

In general, Stimac recommends that users make sure that they are picking the right oven for their application. In certain cases, an oven may not even be necessary; for example, sometimes an incubator is sufficient for drying. Using the right instrument and adding appropriate accessories will tend to keep both users and samples safe, he says.

The vast number of safety features available for lab ovens empower customers to take safety into their own hands. And at the very least, lab oven users would be wise to make a habit of reading their safety manuals.

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

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

WHAT DO BATH AND CHILLER USERS HAVE TO SAY?

Water baths and circulators are used in a variety of settings including industrial and clinical laboratories, academic institutions, government research laboratories, environmental research applications, and food technology. Despite their maturity as a product category, laboratory baths continue their slow evolution, particularly in the areas of controls and user interface.

TOP 7 QUESTIONS

You Should Ask When Buying a Bath or Chiller

1. Does the product have any exclusive features? What sets it apart from other vendors' chillers or baths?
2. Is it important for your lab that the vendor have ISO 9001 certification?
3. What is the warranty period? What does it cover?
4. Are service plans available? If so, is there an on-site option?
5. Does the unit have the appropriate cooling or heating capacity for the application? Is there enough reserve capacity to account for environmental cooling or heating losses?
6. Does the manufacturer offer the necessary accessories for the application? (Tubing, fluid, adapters, electronic interfaces, etc.)
7. Does the manufacturer understand the application and provide a thorough explanation of calculations to recommend the proper instrument?

TYPES

of water bath or chiller used by survey respondents:

STANDARD (GENERAL PURPOSE) WATER BATHS	60%
CIRCULATING WATER BATHS	59%
SHAKING WATER BATHS	21%
COOLED WATER BATHS	20%
BOILING WATER BATHS	12%
WATERLESS BEAD BATHS	10%
STIRRED WATER BATHS	3%
OTHER	3%
STEAMING WATER BATHS	2%

How survey respondents repair their baths or chillers:

Our department	60%
Other	13%
Manufacturer service agreement	12%
Third party service agreement	12%
Multi-vendor service agreement	3%

Nearly 55 percent of respondents are planning to purchase a new bath or chiller. The reasons for these purchases are as follows:

Replacement of aging system	61%
Addition to existing systems, increase capacity	19%
Other (please specify)	11%
Setting up a new lab	9%
First time purchase	0%

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

WHAT DO GAS GENERATOR USERS HAVE TO SAY?

In many laboratories, gas generators are quickly replacing traditional tanks, offering greater flexibility, convenience, safety, and cost-effectiveness. Gas generators offer the ability to produce on-demand supply and specialty blends of highly pure gases for various applications.

Gas generator types used by survey respondents:	
Hydrogen	46%
Nitrogen	46%
Zero Air	26%
Other	16%
Calibration	14%
Purge	14%
TOC	6%

Applications using laboratory gas generators as reported by survey respondents:	
Gas chromatography with flame ionization detection	41%
Other	37%
High-performance liquid chromatography	25%
Gas chromatography with mass spectrometric detection	20%
Fourier transform infrared spectroscopy	14%
TOC analysis	6%
Inductively coupled plasma systems	6%
Nuclear resonance spectroscopy	4%

Of those respondents interested in purchasing a new gas generator, the reasons for these purchases are as follows:	
Cheaper than gas cylinders	27%
Increase safety	22%
Upgrading old system	15%
Other	15%
Starting a new lab process	12%
Switching from helium to hydrogen	5%
Building/renovating lab	5%

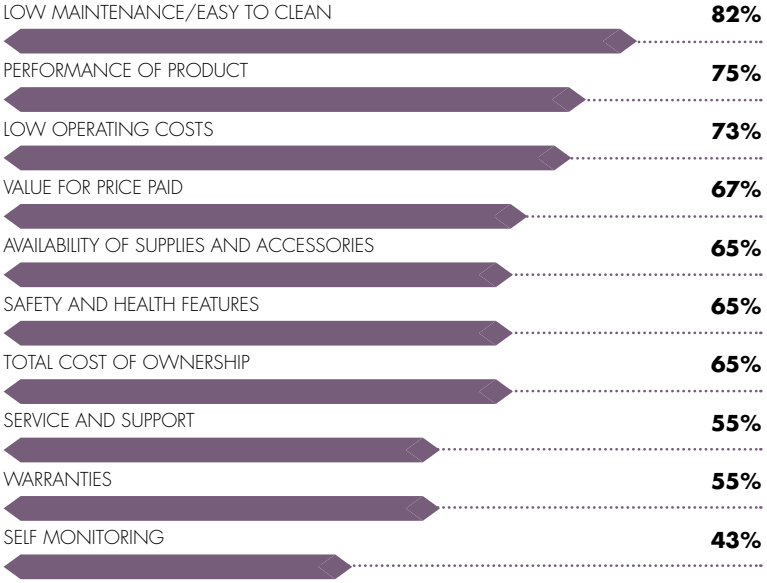
TOP 6 QUESTIONS

You Should Ask When Buying a Gas Generator

1. What is your application? As the range of available gas generators continues to expand, consider what it will be used for. For example, Fourier transform infrared spectroscopy operates best in the absence of carbon dioxide, so users will require a generator that creates CO_2-free gas.
2. Do you require high quality gas? In many cases, gas generators can produce a superior product both in purity and consistency without the risk of contamination during gas-line changing.
3. What volume of gas do you require? Many instruments now require higher volumes of gas. If your space is small, or you expect your needs to increase over time, you may wish to consider a gas generator which will take up much less space than storing tanks of gas.
4. Are long-term cost savings important to your project? Beyond convenience, gas generators save on shipping costs, time-related costs for changing tanks, and managerial costs for managing the safety and supply of tanks.
5. Is noise a factor in your lab? Noise can be both bothersome and present a real health concern for those exposed. If low-noise is desirable, consider a gas generator with detachable or low-noise compressors.
6. What sorts of service agreements are available? Is training in self-maintenance sufficient, or are service representatives available?

TOP 10 FEATURES/FACTORS

Respondents Look for When Purchasing a Gas Generator:

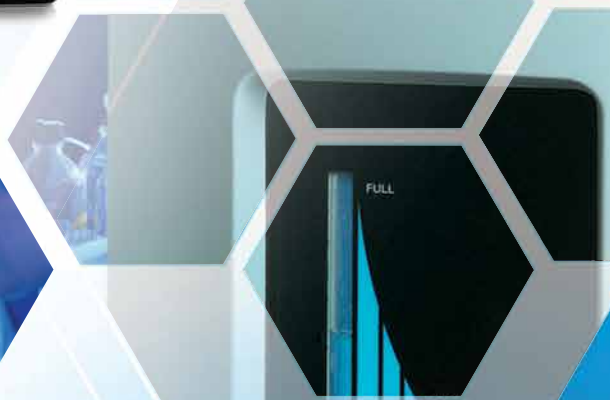


For more information on gas generators, including useful articles and a list of manufacturers, visit www.labmanager.com/gas-generators

Quality Gas Generators from the Brand You Trust

Technology Leader
Most Experienced
Largest Installed Base

personalized solutions for your lab are only a click away at **labgasgenerators.com**



Parker enables its partners in the laboratory industry to work more efficiently and safely by eliminating the danger, cost and inconvenience of gas cylinders. Whether it's directly on the laboratory bench or in a process application, Parker gas generators are the dependable standard to deliver safe, high purity gases. Our leading global presence and portfolio of product technologies is unrivaled within our industry.

Parker

TECHNOLOGYNEWS

ANALYTICAL

LC System

1260 Infinity II Prime LC System

- Delivers excellent performance on routine analyses and provides an ideal front end to the new Agilent Ultivo triple quadrupole mass spectrometry system
- Provides the highest convenience standard in the 1260 Infinity II LC portfolio plus extended pressure range (up to 800 bar), superior quaternary mixing, and specifically designed columns
- Automated instrument features reduce the need for manual interaction

Agilent www.agilent.com

UV/Visible Spectrophotometer

Jenway Genova Bio

- Designed for fast and easy use in life science applications, whilst having a low-price point
- Suited for molecular biology laboratories, biotechnology, biochemistry, and cell biology applications
- Compatible with a wide range of small volume cuvettes, making it an excellent tool for measuring the purity and concentration of DNA, RNA, and other biological samples

Cole-Parmer/Jenway www.jenway.com

Analyzer for AMC Monitoring

AMC-Monitor T-1000

- An all-in-one analyzer for FOUP, fab, and clean-room environment airborne molecular contamination (AMC) monitoring in typical semiconductor applications
- Now based on IONICON's PTR-TOFMS series bundled with the new "AME" analysis software
- Enables the automated quantification of several hundred substances in real-time
- Scalable built-in multiplexing system minimizes analysis costs per sampling point

IONICON www.ionicon.com

FT-NIR System

Spectrum Two™ N

- Designed for laboratory technicians and staff conducting molecular spectroscopy analysis on a wide range of pharmaceutical, food, and industrial samples
- Helps both technical and non-technical lab professionals analyze samples for quality assurance and quality control and to determine compliance with stringent industry regulations
- Combines high-end lab performance with portability
- Offers a number of customizable features

PerkinElmer www.perkinelmer.com

Small-Spot ED-XRF Spectrometer

SPECTRO MIDEX MID05

- A fifth-generation, fast, accurate, small-spot energy-dispersive X-ray fluorescence (ED-XRF) analyzer for precious metal testing
- Delivers improved sensitivity and speed, and represents a smart alternative to fire assay testing
- Incorporates the latest developments in ED-XRF detector technology using high count rate and high resolution
- Provides excellent performance in terms of high precision and accuracy for a wide range of concentration levels, plus record-setting testing times

SPECTRO Analytical Instruments www.spectro.com

Desolvating Nebulizer System

Aridus3

- Is the fourth generation of a specialized liquid sample introduction accessory for ICP-MS
- Includes enhanced element sensitivity (10 times or more) and can greatly reduce solvent-based interferences such as oxides and hydrides
- Provides low-volume sample uptake rates of 50, 100, or 200 microliters/min, preserving valuable sample
- New removable membrane heater block makes cleaning or replacement easy

Teledyne CETAC www.teledynecetac.com

PRODUCT SPOTLIGHT

HIGH THROUGHPUT, LOW COST

NEW ICP-OES SYSTEM FEATURES THE LOWEST ARGON CONSUMPTION ON THE MARKET FOR ICP

In early July, PerkinElmer announced the launch of its new Avio® 500 inductively coupled plasma optical emission spectrometer (ICP-OES). This system is designed for all analytical laboratories running high throughput multi-elemental inorganic analyses for a wide variety of sample matrices.

The new instrument is a truly simultaneous ICP-OES system, featuring simultaneous background correction for faster sample-to-sample time and improved data accuracy, unsurpassed matrix tolerance, and the lowest argon consumption on the market for ICP. It is designed to meet the needs of customers requiring low and high concentration testing for a broad range of analytes in order to meet industry demands.

"Laboratory professionals continue to face an expansive set of challenges, as regulations increase in complexity and require testing for more elements, resulting in the need for higher sample throughput and a significant increase in the types of analyses they need to perform," said Jim Corbett, executive vice president and president, Discovery & Analytical Solutions, PerkinElmer. "Our new Avio 500 ICP system features technological innovations that will help our customers seamlessly test across key application areas while still keeping up with the demands and challenges of increasing sample loads and lowering the analysis cost."

Key features of the system include: vertical plasma with quick-change torch, Flat Plate™ plasma technology, Dual View optical system technology, Universal Data Acquisition, PlasmaShear™ argon-free interference removal technology, and a PlasmaCam™ viewing camera.

The Avio 500 system also leverages the cross-platform Syngistix™ software, for a seamless transition between AA, ICP, and ICP-MS software.

For more information, visit www.perkinelmer.com/product/avio-500-cross-flow-spectrometer-n0810010

Single Quadrupole Mass Spectrometer

ISQ EC

- Seamlessly integrates with an existing ion chromatography (IC) or high performance liquid chromatography (HPLC) system
- Provides excellent small molecule sensitivity and mass confirmation for users
- Chromeleon Chromatography Data Software (CDS) platform has embedded ISQ EC MS instrument control, which enables users to minimize time spent on new mass spectrometry (MS) user training

Thermo Fisher Scientific www.thermofisher.com

Chromatography Slurry Tank Mixing Systems

- Provide uniform mixing and blending of slurry for ease of packing columns
- Offers a unique pre-engineered USP VI PP slurry mixing system that provides mixing uniformity and is very easy to clean via CIP
- Include low level mixing capability for excellent media uniformity during pump out
- Available in the 50-2000 liter range

White Mountain Process www.wmprocess.com

BASIC LAB

Evaporation Systems

TurboVap®

- Now include new TurboVap® LV, II, and EH systems
- Feature enhanced visibility, a compact design, removable/adjustable nozzles, exchangeable manifolds, evaporation flow gradients, and a touchscreen interface
- In parallel, Biotage is introducing a series of Multi-Racks that offer greater flexibility in the variety of different tube and vial sizes that can be processed

Biotage www.biotage.com

Overhead Mixer

Crossover 1540

- Features a ½ horsepower motor delivering 3000 N-cm of torque
- Brings effective mixing to large laboratory, pilot scale, and small production volumes
- Offers the portability and quick installation required by today's flexible and agile facilities
- Designed to mix up to 200 L (50 gallon) drum volumes from 50-1500 rpm, with the option of clockwise or counterclockwise rotation

Caframo www.caframolabsolutions.com

Larger Back Chairs

- Developed to provide increased back support and comfort during extended periods of sitting
- Designed for laboratory, drafting, office, industrial, ESD, and clean room settings
- Back support features 38% more surface area than standard chairs
- Available in both fabric and popular vinyl materials and can be configured as needed by the user
- Feature a 15-year warranty

E Com Seating www.ecomseating.com

Metals Digestion System

HotBlock® 200

- This redesigned system allows customers to perform metals digestion at higher temperatures —up to a maximum 200°C (392°F)
- Available from 25 to 96 wells and accept cup sizes of 15 mL, 50 mL, and 100 mL; custom units are also available
- Features redesigned controllers for greater ease of use

Environmental Express EnvExp.com

Acid Digestion Fume Hoods

UniFlow HDPE

- Specifically designed and built for work with high volumes and concentrations of acids
- Entire superstructure is totally non-metallic and extremely chemical resistant to meet the demands of acid digestion procedures
- Offered in sizes from 48" wide to 96" wide and available with or without a built-in wash down system

HEMCO www.hemcocorp.com/pvcad.html

High Speed Scientific Spectroscopy Camera

Synapse*Plus*

- Offers super-fast electronics while maintaining low noise and excellent signal linearity
- Provides excellent sensitivity for low light and fast kinetics studies in applications such as Raman and photoluminescence
- Available with multiple sensors
- Deep thermo-electric cooled to -80°C, and offer high spectral resolution
- Includes anti-fringing and quantum efficiency enhancement technology

HORIBA Scientific www.horiba.com/synapseplus

Chillers

CS

- Expand the Huber product range with compact and highly affordable recirculating coolers
- Chillers combine cool and smart technology in one unit
- New recirculating coolers further reduce water consumption and lower the operating costs for many applications
- All models are air-cooled and work with R404A refrigerants
- Equipped with bypass, manometer, and sensor to monitor the flow

Huber USA www.huber-usa.com/CS

Potentiometric Titrator

AQUACOUNTER® COM-300A

- Includes free download software and RS-232 cable to connect to the user's computer
- Performs pH, acid/base, complexometric, redox, Karl Fischer, photometric, non-aqueous titrations, and ISE (Ion-Selective Electrode) measurements
- Can also determine TAN/TBN (total acid/total base) in oils and P and M alkalinity
- Stores up to 50 results in memory or downloads results to a laptop or desktop PC

JM Science www.jmscience.com

Gas Generator

Genius 1024

- This nitrogen and dry air generator has been designed exclusively to meet the needs of SCIEX LC-MS systems and has been approved by SCIEX for use on all their RUO LC-MS systems
- Compared with its predecessor, the new Genius 1024 has a significantly increased flow rate
- Designed mainly for LC-MS applications

Peak Scientific peakscientific.com

Top Loading Autoclaves

QCS

- Compact design and operational flexibility makes these autoclaves ideal for numerous sterilizing applications
- Available in a choice of chamber sizes—100 and 150 liter capacities
- Easily accommodate the tallest flasks, fermenters, and bioreactors, but cost one-third as much as a comparable front-loading autoclave
- Are bench-height and mounted on casters, making them easy to install

Priorclave www.priorclave.co.uk

Surface Area Analyzer

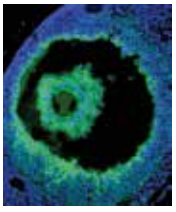
Autoflow BET+

- Designed for high speed, high throughput analyses of powders and porous materials
- Free of the usual vacuum pump noise and oil issues, the quiet Autoflow BET+ quickly prepares and analyzes multiple samples, and measurement progress can be monitored on a mobile device or Windows® PC
- Features a rapid-start-up time, simplicity of operation, and low operating costs

Quantachrome Instruments www.quantachrome.com

CHEMICALS, KITS, & REAGENTS

Hyaluronic Acid Quantification Kit



- Based on a highly specific and tightly binding protein to detect and measure hyaluronic acid, also known as hyaluronan or HA
- A competitive ELISA-like kit using a recombinant hyaluronic acid binding protein (rHABP) optimized to quantify HA polymers of average molecular weight greater than 7.4 kDa in samples such as serum, plasma, and culture supernatant

AMSBIO www.amsbio.com

DNA/RNA Prep Kit

Arcis

- Allows rapid extraction of either DNA or RNA in three minutes with high yields
- Requires two simple steps that are completed in three minutes, to provide high-quality, PCR-ready templates with no need for additional laboratory equipment such as centrifuges or hot blocks
- Ideal for applications such as PCR, qPCR, isothermal amplification (LAMP), sequencing, genetic profiling (electrophoresis), and forensic studies

Cole-Parmer www.coleparmer.com

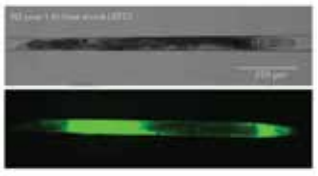
2X qPCR Probe Master Mix

- Created for real-time evaluation of DNA using fluorescent probe-based detection
- Contains FlashTaq HotStart DNA polymerase, a chemically modified Taq DNA polymerase that remains inactive at room temperature
- The enzyme becomes activated after 2 minutes at 95°C
- Also contains dNTPs, MgCL2, and optimized buffer for fast, efficient qPCR
- Optimized for use with hydrolysis based probes such as TaqMan, but is also suitable with other probe-based detection systems

Empirical Bioscience empiricalbioscience.com

Fluorescent Staining Kits for *C. elegans*

RediStain™



- Provide improved visualization of *C. elegans*' structure and function in phenotyping studies
- Expand the toolkit of *C. elegans* research to include the ability to perform structural and functional assays that are standard in cell biology
- Used with the ScreenChip System, offer a more efficient way to study nematode phenotypes and their directly-related underlying genotypes

NemaMetrix http://bit.ly/redistain

Antibody Bio-Analysis Kit

nSMOL

- Applicable to a variety of pharmaceutical antibodies
- This proprietary technique enables selective proteolysis of the Fab region of monoclonal antibodies to dramatically improve the productivity and robustness of LC-MS mAB bioanalysis
- Provides a ready-to-use reagent kit for collecting monoclonal antibodies from blood or other biological samples using immunoglobulin collection resin

Shimadzu www.ssi.shimadzu.com

INFORMATICS

Externalization Technology for Informatics Platform

D360 Partner

- For Certara's D360 scientific informatics platform
- Facilitates collaboration between sponsors and their external research partners
- Provides external research partners with highly secure access to only authorized project data
- Further expands D360's 'faster time to insight' benefit by enabling external collaborators' work to be integrated directly into the research project

Certara www.certara.com

Chemical Structure Drawing Software

ChemDraw® version 17

- Includes new capabilities that enable biomolecular researchers and chemists to advance their data analysis and accelerate their paths to discovery
- Features the Pistoia Alliance's Hierarchical Editing Language for Macromolecules (HELM)
- Equipped with enhanced hotkeys that accelerate molecular drawing, and metadata tagging to make it easy to take notes and mark up documents

PerkinElmer www.perkinelmer.com

LIFE SCIENCE

Flow Cytometer

Navios EX

- Recently received 510(k) clearance from the U.S. Food and Drug Administration to be used in the clinical laboratory in the U.S.
- Delivers accurate, high complexity immunophenotyping using Tetra reagents
- The compact, 10-color Navios EX incorporates the advanced optics and laser technology of Beckman's award-winning CytoFLEX research flow cytometer
- Delivers up to 12 parameters, needed for high complexity assays

Beckman Coulter Life Sciences www.beckman.com

Microplate Reader & Washer Duo

800™ TS & 50™ TS

- Are improved editions of BioTek's legacy reader and washer, the ELx800 absorbance reader and ELx50 washer
- The 800 TS absorbance reader features a color touchscreen interface with easily programmed onboard software, 6- to 384-well microplate reading, and temperature control and shaking
- The 50 TS washer also features easy programming through its color touchscreen, and is compatible with 96-, 384-, and 24-well microplates

BioTek www.biotek.com

Digital PCR System

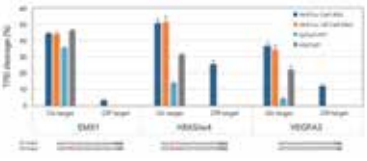
CONSTELLATION®

- With up to five channel filters, the CONSTELLATION is the first ever digital PCR system to offer five color multiplexing
- Capable of displacing qPCR as the method of choice for high-throughput quantification of nucleic acid targets
- Early access CONSTELLATION systems will be installed in Q4 of 2017 with a commercial release scheduled for Q1 of 2018

FORMULATRIX www.formulatrix.com

Cas9 Enzyme Variant

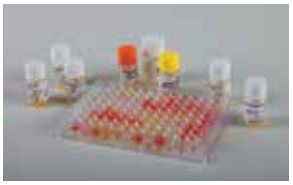
Alt-R® S.p. HiFi Cas9 Nuclease 3NLS



- Extensively reduces off-target effects in CRISPR genome editing without compromising on-target activity
- Is a recombinant S. pyogenes Cas9 mutant that improves specificity while maintaining a high editing efficiency similar to wild-type Cas9
- Represents a major step towards therapeutic use of CRISPR, which has previously borne the risk of the unwanted off-target editing events observed with wild-type Cas9

Integrated DNA Technologies www.idtdna.com

HIV P24 Monoclonal Antibodies



- New additions include HIV P24 275; HIV P24 114; and HIV P24 9.23.11.8.9.4 anti-human monoclonal antibodies
- Designed for use as an integral component within a number of enzyme immunoassay (EIA) testing procedures
- Sourced from mice and processed using various chromatographic techniques to a purity level of > 95%
- Matched antibody pairs are available (coater/tracer)

Immunologicals Group www.immunologicals.com

Automated Cell Culture Analyzer

BioProfile® FLEX2

- Can now be integrated with the Sartorius Stedim Biotech ambr® 15 bioreactor
- Enables rapid at-line sample collection and analysis of massive quantities of key cell culture data
- The combined system provides a unique tool to simultaneously run, sample, and analyze a massive number of cell culture conditions during cell line and media development by Design of Experiments (DoE)

Nova Biomedical www.novabiomedical.com

Benchtop Biomarker Detection System

SR-Plex

- Offers researchers greater access to ultra-sensitive Simoa technology for unrivaled biomarker detection
- Uses single molecule measurements to assess previously undetectable proteins
- Can significantly reduce sample volume requirements when compared to alternative approaches, all in a benchtop format that can be easily integrated with existing automation platforms
- Capable of measuring nucleic acids with ultra-sensitivity, without utilizing PCR

Quanterix quanterix.com

HCV Genotyping Test

SVERSANT® HCV Genotype 2.0 Assay

- Has been granted premarket approval from the U.S. Food and Drug Administration
- Provides simple, standardized method for HCV (Hepatitis C virus) genotype and subtype identification and detection
- Improves lab efficiency and accuracy with fully automated strip processing and an integrated system from nucleic acid extraction and amplification to interpretation
- Identifies all six genotypes and subtypes 1a and 1b

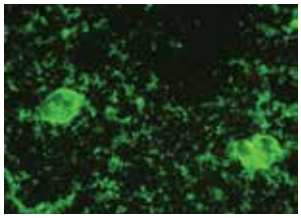
Siemens Healthineers healthcare.siemens.com

Modified Synthetic sgRNA Libraries

- For arrayed whole human genome CRISPR screening
- Leverage the market-leading quality and consistency of Synthego modified synthetic sgRNA for CRISPR/Cas9
- Delivered ready-to-screen and have comprehensive coverage of the human genome, with several guide RNAs selected per gene, using the latest algorithms to enhance knockout efficiency
- Can provide superior screening capabilities over RNAi and CRISPR pooled libraries

Synthego www.synthego.com/libraries

E. histolytica Monoclonal Antibodies



- E. histolytica is an anaerobic parasite that causes amoebic dysentery
- This parasite infects humans and other primates via the fecal oral route
- These new monoclonal antibodies function in ELISA and lateral flow applications and thus serve as excellent tools for the detection of this parasite

ViroStat www.virostat-inc.com

SUPPLIES & CONSUMABLES

Laboratory Bottles

VITgrip™

- Optimized for storage and sample collection
- Built with an ergonomic slim waist to aid in handling, double sided graduations for improved grip and visibility, and tamper-evident screw caps for safe storage
- Bottle thread and screw cap feature a leak-proof design and are both made of PP which make them break-resistant and food-safe
- Available in sizes from 125ml to 2000ml

BrandTech www.BrandTech.com

HEPA and Carbon In-Line Filter Paks

CleanAire

- Designed to be mounted inline in the exhaust ducting from a fume hood or contaminant source up to 1500 cfm
- Filter pak includes a galvanized steel housing with hinged and gasketed access door for filter change-out and molded composite resin inlet and outlet plenums with duct connection collars sized to meet specification
- Both filters include a 30% pleated prefilter

HEMCO www.hemcocorp.com/cafs.html

Automation-Friendly Reservoirs

Clear Advantage™

- Result in the lowest possible dead volume—saving on reagents—reduce plastic waste and simultaneously give scientists a clear view of the pipette tips for the best liquid handling results
- Range relies on disposable, sterile, clear polystyrene reservoir inserts that sit securely within a sturdy, SBS-format, reusable base
- Available in two volumes—150 and 300 ml—individually sealed or bulk packaged

INTEGRA www.integra-biosciences.com

Consumables for Budget Labs

Bemis Parafilm and Kimberly-Clark Kimwipes

- JM Science is offering solutions for basic and essential labware for everyday use
- Feature both Bemis Parafilm (PM992) and Kimberly-Clark Kimwipes (34120)
- Parafilm is a thermoplastic, self-sealing film that minimizes moisture loss
- Kimwipes are made of 100% virgin wood fiber to help prevent contamination and are used to wipe small quantities of solvents or other liquid from hands, tools, equipment, or other surfaces

JM Science www.jmscience.com

Automation-Friendly Tubes

- Now include 1.00ml and 3.50ml tubes with external thread
- Designed with special features for the storage of fresh frozen tissue samples
- Enables biobanks to standardize and automate the handling and storage of tissue samples in the same way as their liquid samples
- Feature a wide opening for easy loading and are shallow for the removal of tissue samples using tweezers

Micronic www.micronic.com

Supported Liquid Extraction Microplate

- This easy-to-use 96-well microplate is designed for high recovery extraction of analytes from biological fluids
- Enables high analyte recovery, free of proteins and phospholipids, without the need for offline steps such as protein precipitation
- Based upon the automation compatible Microlute 96-well format
- Provides fast, reproducible, and economical sample clean-up when used with a simple vacuum manifold or positive pressure device

Porvair Sciences www.porvair-sciences.com

Sterile Jugs

SteriWare Jugs®

- Manufactured and packed in a class 8 cleanroom; full batch traceability is carried out
- Also manufactured using FDA, EC 1935/2004, and EU 10/2011 conforming materials and are BSE/TSE free
- Available pre-sterilized or non-sterilized—sterilization is carried out by gamma irradiation
- Are individually wrapped and feature a comfortable ergonomic design
- Available in 500ml size (other sizes following)

Sampling Systems www.sampling.com

Clear Disposable Liquid Handling Tips

- Intended for use with Air LiHa™, Air FCA™, and Cavro® ADP pipetting options
- Provide cost-effective, verified performance for applications that do not require capacitive liquid level detection (cLLD)
- Designed, manufactured, and tested specifically for Tecan liquid handling options, helping to ensure reliable results time after time
- Especially useful for setting up methods where users can 'see' into the tip

Tecan www.tecan.com/clear-tips

Leakproof Vials

Samco Clicktainer

- Provide sample protection and user safety by enabling correct cap application every time
- Unique lid-lock design of these vials makes them ideal for the secure transport of valuable and often hazardous clinical, research, and forensic samples
- Bear the CE mark and are compliant with applicable FDA regulations
- Available in 120 mL and 90 mL formats

Thermo Fisher Scientific thermofisher.com/clicktainer

Universal Containers

Sterilin

- Specifically lot tested and certified to be free from RNase, DNase, human DNA, and pyrogens, for the rigorous requirements of molecular biology, genomic ,and forensic research facilities
- Aseptically manufactured under controlled, automated cleanroom conditions
- Designed for the safe handling of valuable or potentially hazardous samples, reducing the potential for contamination that could adversely affect analytical results

Thermo Fisher Scientific thermofisher.com/sterilincertifiedcontainers

DETECTING CORROSIVE GASES IN LPG USING COMBUSTION ION CHROMATOGRAPHY

Problem: **Production of natural gas and liquefied petroleum gas (LPG) continues to grow in both the US and North America. Corrosion in refineries producing LPG is of great concern to the industry, as billions are spent annually to mitigate corrosion or repair damage resulting from it. Organic and inorganic halides, which primarily include fluoride and chloride, present in feedstocks break down during refinement and tend to form their conjugate acids, namely hydrofluoric acid and hydrochloric acid. Sulfur, which is often naturally present in natural gas in the form of hydrogen sulfide, can form sulfuric acid during the refining process. These acidic gases are highly corrosive to both processing equipment and combustion engines. Therefore, halide and sulfur levels are closely monitored throughout the refinement process and are used to track these impurities and their origin. This is of vital importance for setting prices of these commodities and ensuring that products are of sufficient purity when traded on the worldwide market.**

LPG is important to industry not only as a final, finished product for sale, but also for use as a feedstock for gasoline refinement. Butane is reacted with propylene, butylene, and other olefins in the presence of an acid catalyst to produce octane through a process known as alkylation. The octane produced in this reaction is mixed with refined gasoline in order to enrich octane levels. Both sulfuric acid and hydrofluoric acid are used in the alkylation process; therefore, it is vital that any excess acid is removed from the finished products. This minimizes corrosion in the refinery as well as in end-use combustion engines.

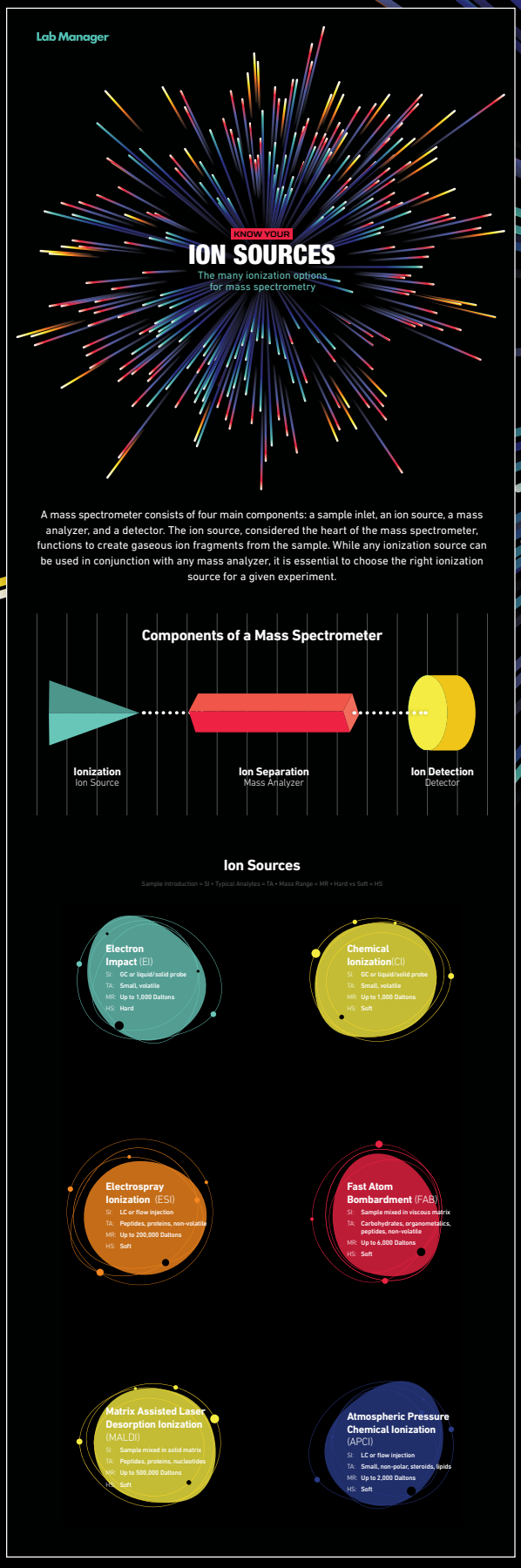
Several analytical technologies, including combustion TOX analyzers, are commonly employed to measure halide content. However, many of these analyzers provide only a total halide value and are unable to speciate which halides are present in a given LPG sample or are unable to accurately measure the quantity of each individual halide species, fluoride in particular.

Solution: Combustion ion chromatography (CIC) is an excellent technique for measuring these impurities in LPG at part-per-million concentrations and is capable of quantifying each halide and sulfur individually and accurately. Combustion IC also has a unique capability and specificity for measuring total fluorine concentrations. It accomplishes this by first combusting an LPG sample at high temperatures, typically 1050 degrees Centigrade, in the presence of water and oxygen. The combustion gases are purged through an absorber solution which effectively traps the free halogen and sulfate anions, which are subsequently separated and detected by an ion chromatograph. Addition of hydrogen peroxide to the absorber solution ensures that sulfur species are converted to a single species in the form of sulfate, which simplifies measurement of total sulfur. Commercial combustion ion chromatographs, like the Metrohm Combustion IC, perform the entire combustion and detection process in a fully automated manner.

Of recent note, a new Standard Test Method for Total Fluorine, Chlorine, and Sulfur in LPG by Oxidative Pyrohydrolytic Combustion Followed by Ion Chromatography Detection (Combustion Ion Chromatography—CIC) has been approved by the American Society for Testing and Materials (ASTM), identified as Test Method D7994-17. Approval of this method signifies the reliability of the technique by both users in industry and by instrument manufacturers. The Metrohm Combustion IC system is fully-compliant with D7994 and features the unique capability to automatically inject various, user-specified sample volumes of LPG for CIC analysis and does so using a single piece of software. All hardware and software components of the Metrohm Combustion IC are supplied and supported solely by Metrohm USA, Inc.

For more information, visit www.metrohm.com

➤*Combustion ion chromatography (CIC) is an excellent technique for measuring impurities in LPG at part-per-million concentrations and is capable of quantifying each halide and sulfur individually and accurately.*



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The many ionization options for mass spectrometry

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labmanager.com/ion-sources

LOAD ALL OF YOUR SAMPLE WITH BIOTIX PIPETTE TIPS

"Pipetting error" is a phrase that is commonly heard in research laboratories. When preparing reagents and master mixes, pipetting error is factored in. What is not typically discussed or published are the causes and ramifications of pipetting error. Pipetting error can lead to no or inconsistent results especially with rare samples and low abundance molecules. Researchers waste hours of time, reagents, and valuable samples accounting for inconsistent results. User error is a common problem. However one variable that many laboratories do not consider is the pipette tip.

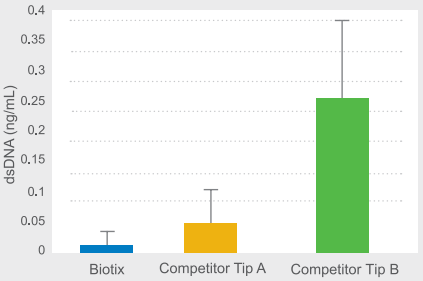
While barrier tips or "filter tips" can reduce sample carryover, they do not address the issue of molecules sticking to the plastic or sample retention. In Figure 1, sample retention by non-low retention tips is demonstrated with green dye compared to Biotix® low-retention tips with X-Resin® technology. Unlike competitor tips that are batch coated post manufacture with non-stick materials, Biotix tips are made from X-Resin that has naturally low retentive qualities. This leads uniform and consistent performance within and across batches. In addition, Biotix tips are clear improving visualization of samples within the pipette tip.

To better understand the effect of pipette tips on sample retention, Biotix tips were compared to competitor A (a low retention tip) and competitor B (a standard tip). For each pipette tip, 100 µl of fluorescent DNA was drawn up and down 3 times with final dispense back into the original tube. Following that, 100 µl of dH2O was drawn up and down 3 full times and dispensed into a fresh 0.5 ml tube. Resulting DNA samples were analyzed for residual fluorescent signal originating from retention of DNA solutions on the pipette tip. As shown in the table and graph there was a significant difference across the 3 brands of pipette tips. Biotix tips demonstrated the best consistency and efficiency for the delivery of DNA samples.

In addition to market leading low sample retention, Biotix tips incorporate several innovations including: FlexFit® and Blade® technology. Pipette tips with FlexFit technology are engineered with flexible proximal tip ends to reduce pressure from insertion and ejection forces reducing pipetting-related injuries. FlexFit also results in a better seal that can improve accuracy. Blade technology minimizes the surface tension at the distal end of tips leading to better precision and reduced sample carryover.

Biotix universal pipette tips are available in a variety of sizes with and without filters. For researchers using Rainin™ LTS™ Style pipettes, the xTIP® by Biotix is an excellent choice. Like the universal tip, xTIP is made from low retention resin and incorporates FlexFit and Blade technology.

Residual DNA Carryover in Tips



Sample	5 µl	10 µl	Mean (µg/ml)	SD
Negative Control	Too Low	Too Low	Too Low	Too Low
DNA 20 µg/ml	22.000	11.000	16.500	7.778
Biotix - 1	0.036	0.047	0.042	0.008
Biotix - 2	Too Low	Too Low	Too Low	Too Low
Biotix - 3	Too Low	Too Low	Too Low	Too Low
Competitor Tip A - 1	0.119	0.115	0.117	0.003
Competitor Tip A - 2	Too Low	Too Low	Too Low	Too Low
Competitor Tip A - 3	0.028	0.426	0.035	0.010
Competitor Tip B - 1	0.130	0.448	0.289	0.225
Competitor Tip B - 2	0.367	0.203	0.285	0.116
Competitor Tip B - 3	0.205	0.185	0.195	0.014

Biotix
Fluid Innovation
9880 Mesa Rim Rd.
San Diego, CA 92121
858-875-5000
www.biotix.com

CAPLUGS EVERGREEN SLIDE-FIX™ SLIDE JARS

Slide-Fix™ Slide Jars from Caplugs Evergreen are available empty or prefilled with 95 percent ethyl alcohol. The jars can be used in a variety of applications, including preservation and transport of Pap smear slides, post-surgical tissues and fine needle aspiration (FNA) biopsies. Slide jars have a volume of 30 mL to accommodate and protect up to four slides. The jars come with blue, orange, green, lavender, fuchsia, red or natural colored caps for color coding, as well as a chocolate-colored jar for light sensitive procedures.

Prefilled Slide-Fix Slide Jars contain approximately 25ml of denatured 95 percent ethyl alcohol, providing an ideal environment to preserve Pap smear samples. Prefilled jars are available in 100-count cases. Unfilled jars are available in 25-, 200- and 1,000- count cases, and can be used to protect up to four slides in transit.

For easy inventory, the caps of the Slide-Fix Slide Jars come in a variety of colors for color coding and an opaque chocolate-colored jar for light sensitive procedures. The jars can also be ordered with holding trays for storage.

Evergreen labware products are now backed by the engineering and manufacturing expertise of Caplugs. Caplugs Evergreen offers more than 1,000 catalog single-use labware products designed for a variety of industries, including Clinical Chemistry, Microbiology, Histology and Life Sciences.

In addition to its catalog products, Caplugs Evergreen can also produce custom solutions with its Class 8 certified Clean Room, six different molding processes and thousands of available material options to meet medical requirements and specifications. A custom solution can specifically cater to medical and laboratory needs by providing traceability, record retention and strict process controls. And as a trusted supplier to more than 2,500 medical customers, Caplugs Evergreen brings more than 65 years of experience to the labware market.

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www.evergreensci.com

ASK LINDA

FINDING TALENT

QUESTION:

Dear Linda,

My research lab has just been given permission to hire two new entry-level researchers. We are a small lab so it's very important that anyone we hire be well qualified, have a great work ethic, and, most importantly, fit in well with our group. None of our work is really routine, so we need workers to be able to change tasks and focus as needed. Our HR department has posted the jobs internally and we have done some cursory searching by word of mouth, but this doesn't seem very effective. Can you suggest some better ways to find the right candidates for our lab?

Thanks,

Frank

ANSWER:

Dear Frank,

No doubt, finding and retaining talent is one of the greatest challenges lab managers face. It's so important, yet not at all straightforward.

In addition to your internal job posting, I'd suggest checking out some job boards, such as Monster, ScienceJobs, ResearchGate, among others. Labs also often turn to social media for help in attracting and holding on to workers. Experts advise labs to find ways to tap into the networking potential of informative blogs that discuss industry staffing trends and salary scales, and even start their own forums of interest, including LinkedIn groups.

Some labs have also had success by tapping into local organizations and groups associated with their particular area of research, such as the American Association of Clinical Chemistry, American Society of Mass Spectrometry, and American Chemical Society, among others. These groups have broad reach via communication with their large numbers of members. Sometimes looking for specific subject matter experts can prove more effective in finding the right candidate.

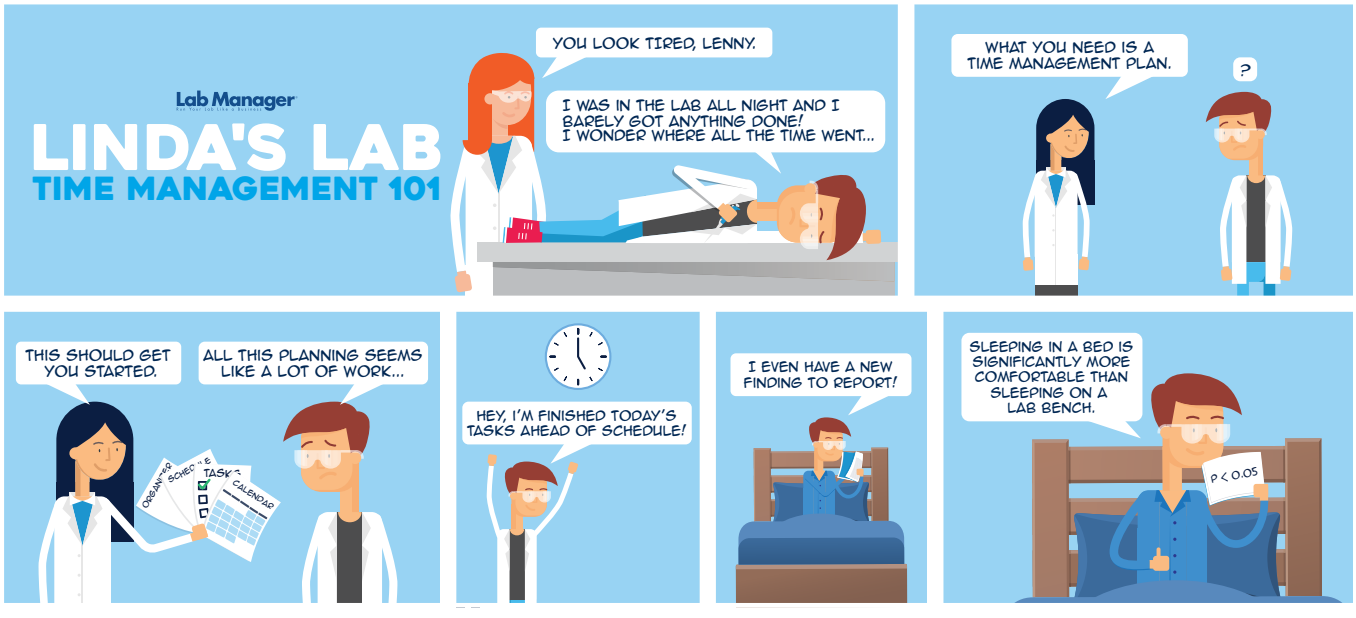
Hope this helps.

Cheers,

Linda

HAVE A QUESTION FOR LINDA?

EMAIL HER AT: *LINDA@labmanager.com*



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LAB MANAGER ONLINE

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

1 Science Laboratory Safety Symbols and Hazard Signs, Meanings

Recently, the editors at *Lab Manager* put together a refresher on the meanings of key laboratory safety and hazard signs. This online exclusive also includes our design team's own creative take on these standard signs and symbols. Use it to brush up on your knowledge or share with your staff to ensure they are up to date as well.

Read more at **LabManager.com/safety-signs**

2 Trending on Social Media: Measuring Chemicals in Cannabis

As of September 18th, *Lab Manager*'s top September issue article posted to social media was our Industry Insights on measuring chemicals in cannabis. This article shares the key testing challenges in this growing industry, the available methods and equipment for testing, and where the testing industry is headed.

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

3 Most Popular Webinar

Last month's top webinar on LabManager.com with 375 registrants was " Water Testing and Analysis: Tools, Tips, and Techniques," sponsored by Metrohm USA. This webinar shared the latest tools for water sampling and analysis, along with practical and financial considerations when investing in new equipment. Though it ran on September 14th, you can still catch it on demand at the link below.

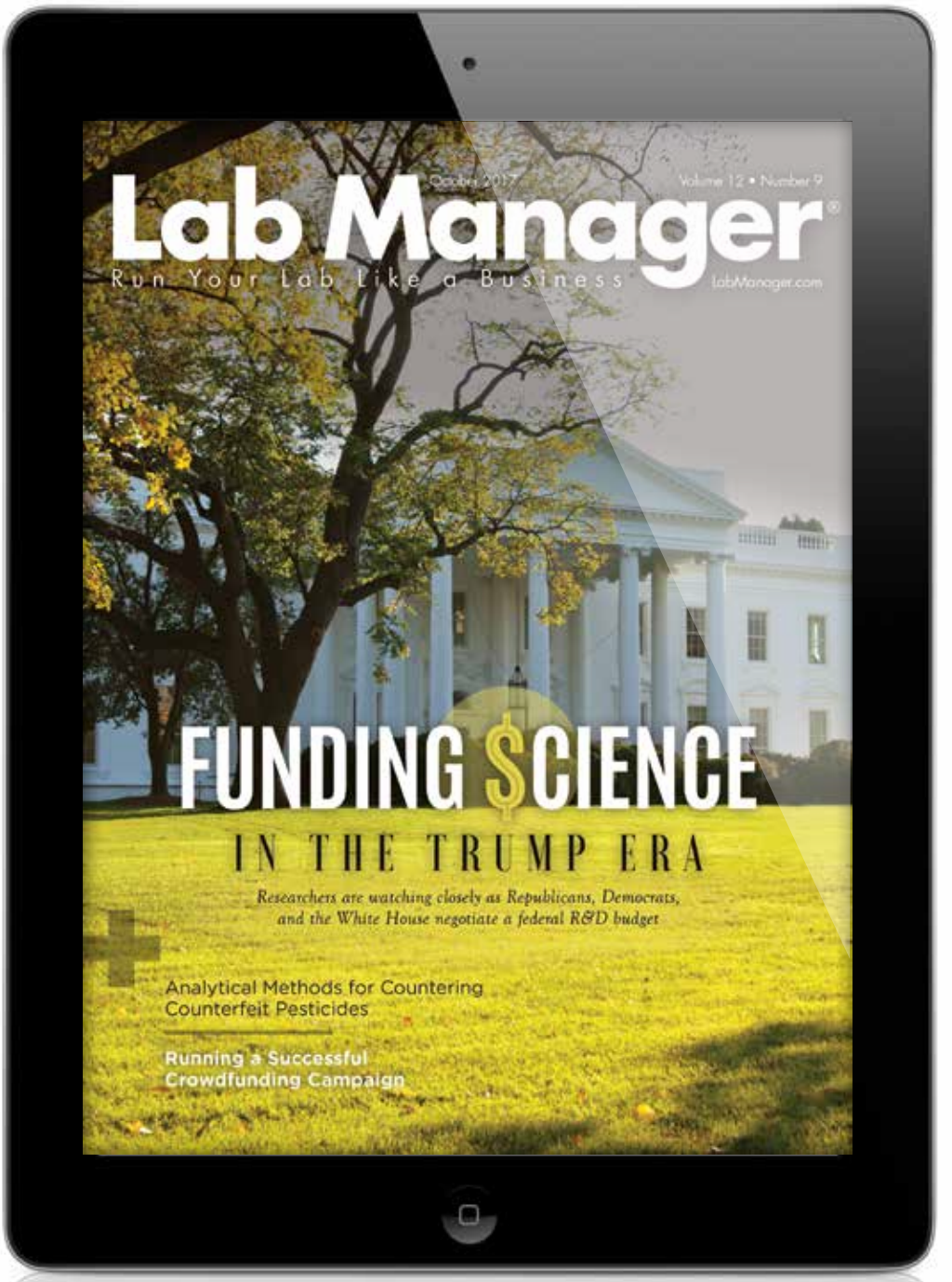
Read more at **LabManager.com/watertestingtools**

LabManager.com

NEXT ISSUE ➡

Lab Management Matters

Management skills are important for science careers of all types. Whether you work at the bench or away, the ability to organize your work and supervise those under you is critical. Laboratory managers are often promoted from the ranks of the technical staff, but if an individual has the capacity to learn science, they can learn the necessary management skills, given the desire and aptitude to do so.



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