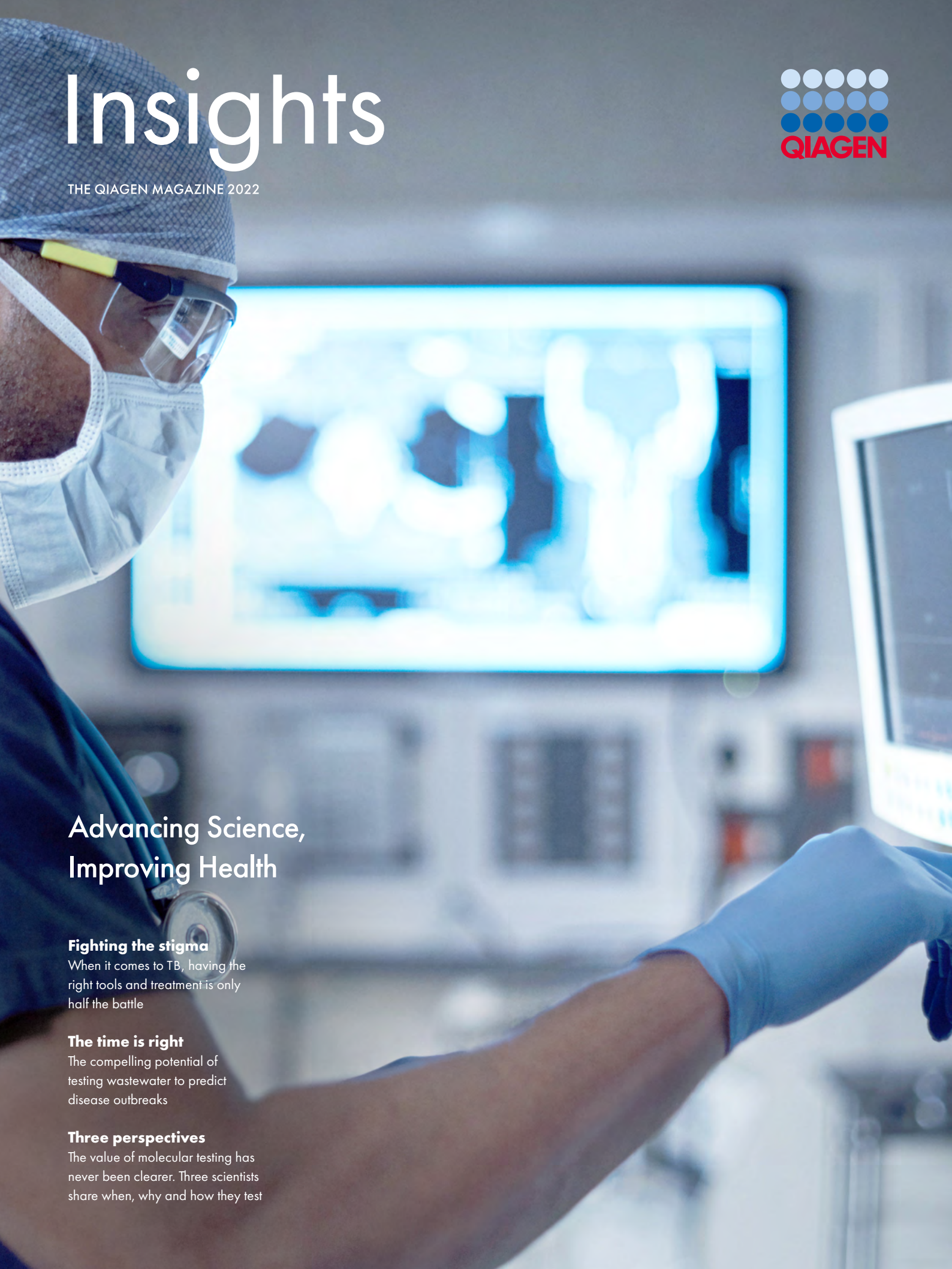
Insights

THE QIAGEN MAGAZINE 2022



Advancing Science, Improving Health

Fighting the stigma
When it comes to TB, having the right tools and treatment is only half the battle

The time is right
The compelling potential of testing wastewater to predict disease outbreaks

Three perspectives
The value of molecular testing has never been clearer. Three scientists share when, why and how they test

We identify the key challenges holding customers back and deliver solutions so they can achieve greater success, ultimately helping them exceed their own expectations and gain the insights critical for their work.

Sample to Insight is our strategic framework that puts the needs and challenges of our customers front and center.

Advancing Science, Improving Health

The COVID-19 pandemic upended our expectations, destabilized our certainties and changed our lives. But change propels innovation. It's compelled us to develop new technologies, adapt our systems, rethink our priorities in work and life, and shine a spotlight on global public health.

Change may be the only certainty, but we can anticipate where we need to focus our efforts.

We know that in a world driven by climate change, sustainability is not an option but a requirement. Even small changes can have a large impact when scaled up.

We also know that there will be another pandemic. Learning from the inspiring successes – and hard lessons – of COVID-19 gives us an advantage against the next pathogen. From creating data-rich surveillance systems to strengthening supply chains, preparedness is the key.

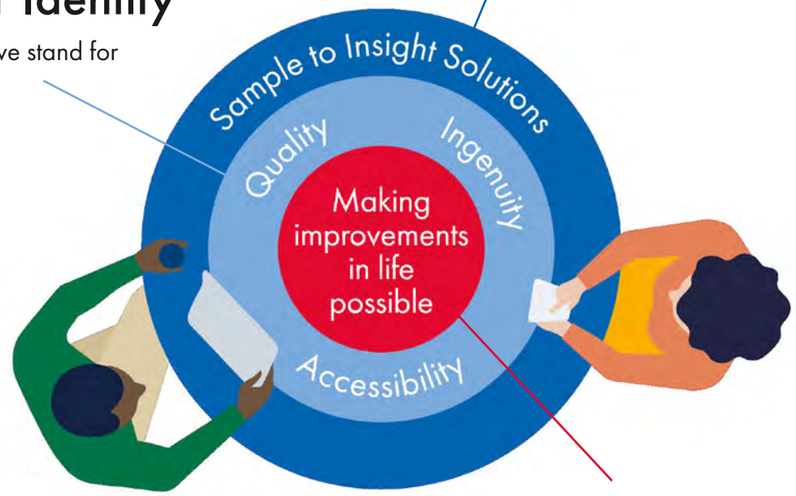
And we know that revolutions in the life sciences are ahead. We QIAGENers are passionate and enthusiastic about our products, instruments, services and software. As change comes, we'll continue to help our ingenious customers advance science and improve patient outcomes.

Our Mission

Why QIAGEN exists

Our Identity

What we stand for



Our Vision

What we want to achieve

Our Strategy

Leverage our expertise for quality and leadership in Sample technologies – enabling insights from any biological sample – to capture broad growth opportunities in areas of life sciences and molecular diagnostics.

Focus on providing solutions to improve our understanding about the building blocks of life – DNA, RNA and proteins – that advance science and improve outcomes for patients, particularly in infectious diseases, oncology and immune response.

Where we play

Our focus:

- Grow in a $11 billion market, of which $6 billion in our 5 Pillars of Growth
- Cross-fertilize investments across life sciences and molecular diagnostics
- Maintain relevant R&D investments (>9 % of sales) to create differentiated solutions
- Build out global presence – go local in markets where it makes sense

How we win

Our top priorities:

- Consistently deliver on our commitments
- Create top 1 – 3 leadership positions, especially in our 5 Pillars of Growth
- Unleash EMPOWER culture driven by accountable "doers" taking ownership
- Embrace digitial mindset to enhance R&D, operations and customer centricity

Aspirations

Our desired outcomes:

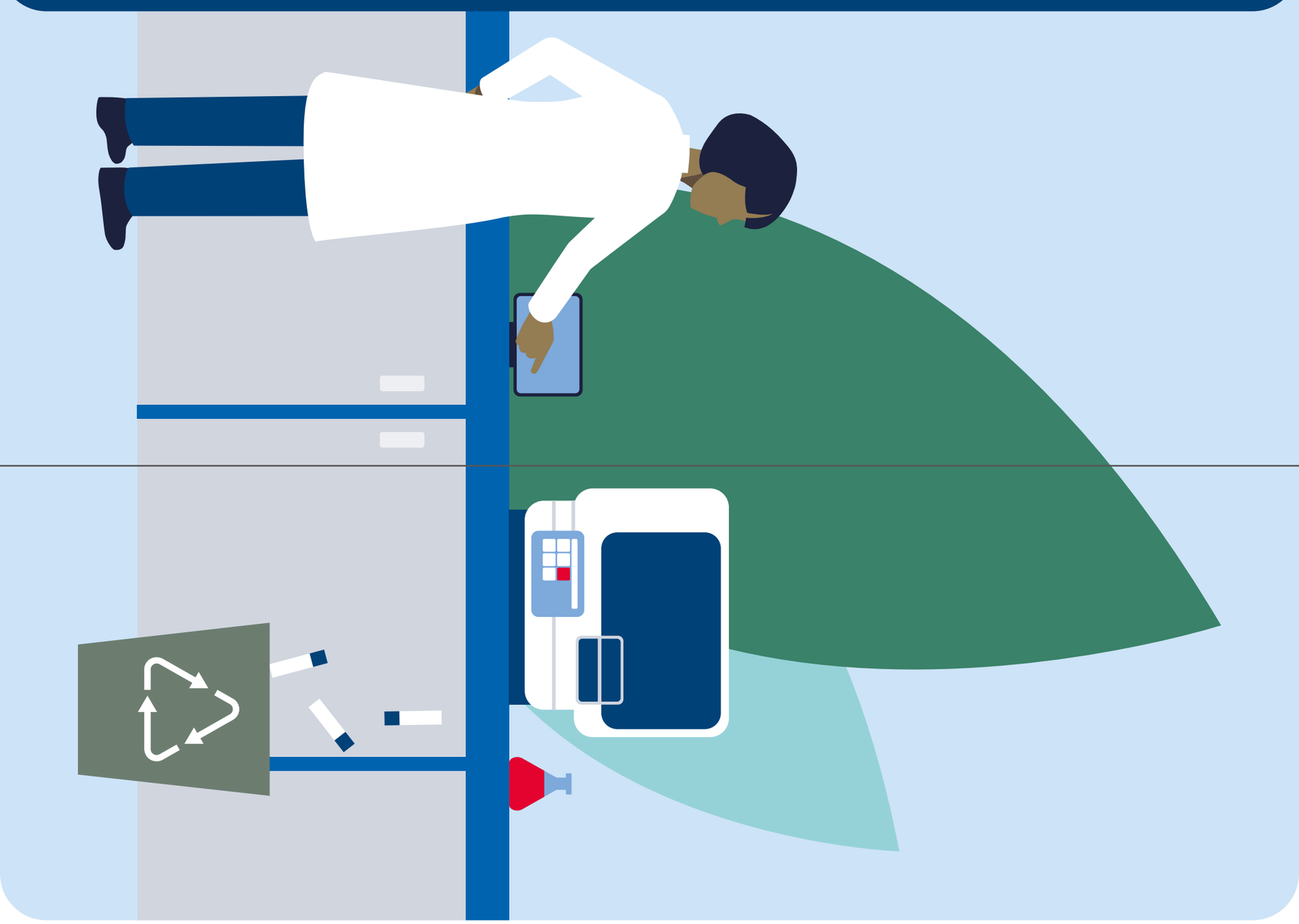
- **Impact**
  Helping to advance science and improve patient outcomes
- **Growth**
  Above-market growth and returns help to fuel new opportunities
- **People**
  Employer of choice with diverse and inclusive teams
- **Quality**
  Strong reputation for excellence, reliability and empathy

Content

Preparedness
How can we prepare for a future outbreak?

Sustainability

What are we doing to promote all aspects of sustainability?



Healthcare Access

How do we provide access to healthcare globally?

Future Technologies
How can science shape the world of tomorrow?

Q&A with the CEO

CEO Thierry Bernard explains why QIAGENers are "at the right company at the right time," and why customers and employees are just as important as shareholders to QIAGEN's goals of advancing science and preventing disease.

Thierry, let's start with world events in 2022. What are your views on the war in Ukraine, the world we're seeing today, and developments surrounding the pandemic?

Thierry: It's obvious that the world and international governance we've been living under these last 30 years died on February 24, 2022. The start of the Ukraine war once again showed that we need to learn to live in a very fast-changing, disrupted world. International peace is a grail that too many people and countries took for granted for too long.

Companies always have to carefully analyze the environment and prepare for the worst. For example, we started talking with our teams about Ukraine and Russia at the end of November, in case the situation escalated. But no one could have imagined then where we stand today.

Now we're not only living in a very dynamic and volatile macro-economic situation, but in a world where pandemics will recur. This is an extraordinary set of challenges in a remarkably short time.

During the last two years, we've emerged as a stronger, more focused company with a clear strategy and empowered QIAGENers. We have a renewed sense of purpose, and we've come together to tackle some incredible challenges. With over 6,000 employees and over $2 billion of annual sales, we have a strong commitment to social responsibility. I always try to separate business from politics, but in many events they become intertwined, so we have to take a stance.

We are more than just a business. We are part of the societies in which we operate.

And what does that mean on a practical level?

I strongly believe it's important to take a stance on issues of very broad public interest. I don't expect people to always agree with

"We're investing in our future and building on our strengths."

Thierry Bernard
Managing Director and CEO, QIAGEN

this approach. But, yes, we are in favor of compulsory vaccination. Yes, we stand with Ukraine. Yes, we have a duty to help when a natural catastrophe strikes anywhere in the world, like in 2021 in Germany with the devastating and deadly flooding near our headquarters in Hilden.

What about the economic situation?

There is no doubt that uncertainty will be the key word in 2022. QIAGEN should always think long-term. But it's also our commitment to QIAGENers to *always* find the right balance between growth and expenses. Investment is in our DNA, and we prove it every day in recruiting new talent, training our staff, investing in R&D and building up infrastructure. But expenses without return and profitability would be the worst scenario for QIAGEN, so we're making sure to maintain our flexibility while thinking long-term.

How have your employees – QIAGENers – developed during this unprecedented period?

We've developed a renewed sense of belonging, a renewed pride in being QIAGENers.

From delivering the future success of our company, to organizing vaccinations for our employees, to helping save lives in the pandemic or those of our neighbors in the brutal war in Ukraine, I'm humbled and sincerely thankful to our QIAGENers. We stood as one company, we stood together – against COVID, and simultaneously moving ahead as an independent company after the discontinued takeover offer. We're not a perfect company. We identify with humility, openly discuss our weaknesses and areas for improvement, and strive to address them one by one. Our QIAGENers showed what it means to be reflective, agile and astute.

During this period, our culture has been going through a transformation that we call "Empower." We've bolstered our culture of accountability, ownership and business mindset. It's had a profound impact on every part of the company. Our people are at the heart of this initiative. More than 300 Empower Ambassadors have trained over 2,400 colleagues in workshops to drive the behaviors that are critical to shaping our future. Empower is a cultural journey, and that takes time, at least two to three years.

Where will this cultural journey lead QIAGEN?

The biggest benefit is openness – we speak frankly in a respectful manner with each other about how we operate, without fear of retaliation. And it's our duty to share information – because information is power – at the speed of light within the organization, and then take action. Based on feedback from across QIAGEN, our leadership has made pledges to act in six areas: accelerate customer centricity, simplify how we operate, reduce silo thinking, foster a growth mindset, empower our leaders, and increase transparency.

This new company culture is also about initiative, ownership and execution. Suddenly, without being guided by corporate initiatives, people in so many different parts of our company – say in China, Mexico, Brazil – are making QIAGEN a great place to work and attracting top talent. In Poland, in Romania, our colleagues did not ask – they acted – to confront the humanitarian crisis in Ukraine, helping people in desperate need. That's because people are empowered and take action. This is a culture of "doers." This is the company I want.

What does this mean for the operational strengths of QIAGEN?

The backbone of a global, publicly listed company like QIAGEN – which became a member of the DAX-40 Index in 2021 – are its stakeholders, and there are many. You cannot create value for shareholders without taking into consideration the needs of other stakeholders, especially those of our customers and employees.

Our focus is on setting realistically ambitious goals that support all of our stakeholders, and then executing them – what we give to our customers, what we deliver to the market, to our investors, to our QIAGENers. Delivering on our commitments. Just as important is developing balance, and with good reason. There's always going to be one product area, region or something else that's going to have trouble. So we want balance – across our customers in the areas of Life Science and Molecular Diagnostics, across the world in terms of sales among our regions, and among our Five Pillars of Growth. Two of these pillars – Sample Technologies and QuantiFERON – are established market leaders, while the other three – QIAstat-Dx, NeuMoDx and QIAcuity – are in their early commercial stages.

QIAGEN has been restoring trust by delivering on commitments quarter after quarter, year after year. We've become a stronger company with improving sales and profitability that have led to record levels of cash flows and a powerful balance sheet. We're investing in our future and building on our strengths.

During 2021, and already this year too, we've continued to prove that QIAGEN is COVID-relevant, but not COVID-dependent. In 2021, COVID-related sales rose 13 %, but even more impressive was the 22 % growth of non-COVID products. Make no mistake, our focus is clearly on the non-COVID business. This is the long-term future of our company. QIAGEN was here way before COVID-19, and we'll continue to be here long after this pandemic comes to an end, which will hopefully be soon.

Anything else?

One thing that society has learned – and not just QIAGEN – is that diagnostics are a critical asset for any kind of healthcare policy. Whether it's an industrialized country or a fast-growing emerging market, the demands of COVID-19 have established the superiority of molecular testing. This has shown that QIAGEN – and our QIAGENers – are at the right company at the right time.

But let's never forget that we need to lead this company with a lot of humility. It's key to always consider how to move and become better. The main risk of being Number One is the risk of becoming arrogant and complacent. We've seen that many times in our markets, and that includes QIAGEN with our HPV test for cervical cancer detection. Humility means always being open to new ideas, never falling into the "been there, done that" mentality, never asserting that we're better than others, but always striving to become better.

How do the Five Pillars of Growth play into this strategy and determination to deliver on commitments?

The strong focus on our Five Pillars of Growth is key for our success. This is anchored in our strategy. We want to leverage our expertise for quality and leadership in sample technologies – enabling insights from any biological sample – to capture broad growth opportunities in the areas of Life Science and Molecular Diagnostics. And as part of that, we want to provide solutions that improve our understanding about the building blocks of life – DNA, RNA and proteins. We want to advance science and improve health outcomes for patients, particularly in the areas of infectious diseases, oncology and immune response.

Being a company of our size requires us to be more agile than larger competitors. Focus is not an option – it is a condition for excellence, and also for survival. The challenge at a company of our size is always critical mass. So we need focused innovation. If you spread the company too thin, you kill it. That's why we remain focused on the areas where we compete, anchored by our Five Pillars.

What is your top priority?

Our highest priority is to capture and maintain the top 1 – 3 positions in the areas where we compete, especially in the Five Pillars. These are all product groups with significant potential and represent more than $6 billion of the total market opportunity that QIAGEN has these days, out of a total of over $11 billion.

These pillars are built on our absolute leadership in sample technologies, a position we've reaffirmed during the COVID-19 pandemic. Another is QuantiFERON-TB, the gold standard blood-based test that has now been used for more than 100 million people for the detection of tuberculosis. TB unfortunately remains a persistent global killer that has been overshadowed by COVID-19, and every year, it actually leads to more deaths than AIDS and malaria combined. The uptake of our newer pillars – QIAstat-Dx for syndromic testing, the integrated clinical PCR

The new QIAstat-Dx Rise and cartridges are designed as a closed system for higher-throughput syndromic testing.

"We need focused innovation. If you spread the company too thin, you kill it."

Thierry Bernard
Managing Director and CEO, QIAGEN

testing platform NeuMoDx, and our entry into digital PCR with QIAcuity – are building foundations to create fresh waves of growth.

We also targeted R&D investments, which totaled about 8 % of sales in 2021. We are aiming to reach 9 % on an annual basis to drive mid-term growth.

But we're not building a two-tier company – people working on the Five Pillars of Growth and then people working on the rest of our portfolio. We're not forgetting the other areas of our portfolio.

What are these other areas?
These are areas where QIAGEN has developed solid leadership positions as well – flourishing and growing. An example here is our portfolio for supporting customers in genomics, particularly through our bioinformatics business QIAGEN Digital Insights, and the contributions we're making to Precision Medicine through our portfolio of more than 30 co-development agreements with leading pharmaceutical companies to create companion diagnostics tied to new oncology therapies. Our positions in liquid biopsy and forensics are solid foundations of QIAGEN; the OEM, Dialunox, Quanta and Tiangen portfolios are proof of our diversity and agility.

Image left: QuantiFERON-TB, the gold standard blood-based test, has now been used for the detection of tuberculosis in more than 100 million people.

How do you see things shaping up for QIAGEN now that you're moving into a new phase beyond the COVID-19 pandemic?
Let me reaffirm that we have to be smart and agile. During the pandemic, we did this with QIAprep&amp, a solution that our Life Sciences team developed, and which completely changed the paradigm for high-volume COVID-19 testing.

Let me also reaffirm that we're not just a Molecular Diagnostics company, and we're not just a Life Science company. We're a hybrid company, cross-fertilizing advances in Life Science labs around the world into clinical developments that can improve patient health outcomes through novel Molecular Diagnostics. That is also a core element of our strategy.

What does this mean for your customers and other stakeholders?
Above all, it means that QIAGEN can have a tremendous impact in helping to improve our societies in a sustainable way. This is part of creating value for our stakeholders, and that goes beyond delivering growth and creating returns that can fuel new opportunities.

Creating new opportunities also involves embracing the digital revolution. Let me tell you about an example. Our customers are more than just a clinician, the head of a laboratory or a researcher. They are a person with a family and with outside interests. They have a life beyond the lab. They increasingly want our QIAGENers to use their ingenuity to help them be more efficient at work and get more out of life. This is what we can offer with QIAsphere, which provides remote access to digital results from our instruments. The first system is QIAstat-Dx, and others are in development. It allows customers to stay home with a sick child, or attend school. This device typifies our goal to be a step ahead of what our customers are seeking.

I also want our QIAGENers to be more accessible to our customers. This is critical to developing empathy and better understanding their needs. Accessibility and ingenuity are essential, and complement our long-standing commitment to quality. Without quality, we wouldn't be even talking to customers. Quality is a given. And that's what we stand for: Q-I-A – Quality, Ingenuity and Accessibility.

How is QIAGEN pursuing its sustainability goals?
Environment, Social and Governance topics are not just a fad. We really believe that we can have an influence on the environment and make important contributions to society. And having a strong governance structure in place is essential to making that impact.

We're making progress in so many areas – like reducing plastic and paper waste, and making a commitment in 2021 for QIAGEN to become net-zero in carbon emissions by 2050.

But we have so much more to do. Just one example: I'm especially proud of our efforts toward achieving greater diversity, which is improving across both the middle and upper levels of management. This is reflected in QIAGEN having more than 34 % of its management positions held by women.

And we must become even more inclusive in the coming years – geographically, culturally, in terms of sexual orientation, age, and a much broader range of capabilities and perspectives. Our products and solutions aren't just for those in privileged countries. They must also address the needs of emerging countries and be specifically designed for them as well. Why? Because we have a commitment to leave no one behind.

Cultivating empathy as a core cultural DNA element of QIAGEN. Empathy starts internally – toward every one of our QIAGENers all over the world. If one falls, we all fall. So we care about every QIAGENer, and everyone counts – from the people at the reception or those making sure our offices stay clean to the higher-level managers. But we also have empathy toward the external world. We will never turn a blind eye to what is happening around us.

This is what we should strive for every day. As I have said many times, I really believe in our QIAGENers. We have the people. We have a focused portfolio of very relevant solutions. We have the full support of our Supervisory Board. So with a growing mindset of execution and accountability, with no arrogance, no complacency, and a culture of "doers" around the world, I think we can all write a new chapter in the history of QIAGEN.

"We are developing fast and accurate testing technologies, strengthening the supply of critical reagents and plastics, and implementing stringent safety measures to protect our employees."

Kerstin Steinert, Ph.D.

Vice President, Head of Global Product Development
Life Sciences and Genomics Services, QIAGEN
Head of the Pandemic Preparedness Task Force

Ready for the next time

How can we prepare for the next pandemic?

Kerstin Steinert, Ph.D.

QIAGEN created a task force in early 2022 to incorporate all we'd learned in the current pandemic to prepare for any future pandemics. Our core team represents different Executive Committee areas. There are seven of us. Just one of the workstreams is my area – R&D. Another stream is manufacturing, and another is finance, for example. We will of course need support from all departments, but we want to keep the core team small in order to be agile and efficient.

We want to conserve the lessons from our experiences. Overall, I would say we did pretty well. For example, our Diagnostics colleagues very quickly launched the COVID-19 assay for our QIAstat platform. Within a few months we also developed a completely new innovative product – the QIAprep&amp, which allows extremely high throughput and easy scalability for public health needs. This was a real success story because a completely new product had been developed in record time. Within the task force and together with the molecular diagnostics R&D team, we're now defining how to most quickly develop and get regulatory approval for new assays in future emergencies.

In Product Management and R&D, we're defining new products and figuring out how to get them to market as quickly as possible. But what do those new products look like? Can we narrow down the number of products we recommend for pandemic preparedness? How can we be ready to scale up manufacturing when it's needed? One step is identifying which products are most easily scalable and what it will take to scale up the more complex ones. We're also looking into partnerships with external suppliers of raw materials, as well as insourcing some critical materials.

Safeguarding our sites and workforce is just as important. That's something else we did well. Quite early in the pandemic, we set up internal testing for employees. Other companies shut down their factories because they had spreads of COVID. We couldn't risk that. We used our own assays – especially the QIAprep&amp – and our own infrastructure of labs to take samples from our workforce, quickly identify positives and track their contacts. We completely avoided any spread of the disease among the workforce. We didn't lose a single shift.

We're massively increasing the production capacity of test components, strengthening the supply of critical reagents and plastics, developing fast and accurate testing technologies, and implementing stringent safety measures to protect our employees. By committing substantial resources to these efforts, we're making sure that we're one step ahead of the next pandemic.

"How do we ensure the testing infrastructure is as healthy as it can be, so that patients are also as healthy as they can be?"

Susan Van Meter
Executive Director, AdvaMedDx

Susan Van Meter

Based in Washington, D.C., AdvaMedDx represents around 80 manufacturers of in-vitro diagnostic (IVD) tests and technologies. We drive an annual policy and advocacy agenda that is designed to extend the reach of quality diagnostic testing for all diseases and conditions. We focus on improving the regulatory environment to embrace innovation –and also payment and coverage to ensure that innovators can reinvest and continue to innovate.

Throughout the pandemic, there were innovations and a continued mobilization of manufacturing. In March 2020, the U.S. had around 12,000 automated molecular instruments used by laboratories to run COVID-19 tests and other molecular tests. By March of 2022, that 12,000 had been augmented by 110%. That's extraordinary. Now we have well over 25,000 automated molecular instruments in public health labs, hospital labs and reference labs across the country.

We track data week over week on the molecular tests that are shipped across the U.S. from among the largest manufacturers that have a U.S. presence, including QIAGEN. To date, they've shipped over 800 million tests in the U.S. alone – and that's just the laboratory-based molecular testing. There's also serology testing, antigen testing and wastewater testing taking place. I think those two statistics really speak volumes about the magnitude of industry mobilization.

But that's not just important for responding to COVID. It's important for thinking about how we prepare for a future emergency, and how we think about extending the reach of testing for all diseases and conditions. Diagnostics are foundational to inform clinical decision making. The earlier we can screen, detect, diagnose and set an informed clinical pathway, the healthier we all are.

How do we ensure the testing infrastructure is as healthy as it can be, so that patients are also as healthy as they can be?

We've been heartened by the wide recognition of the value of diagnostics. We've also seen that point-of-care tests are really demonstrating their mettle. Those near-patient testing instruments have been broadened for use in pharmacies, clinics, physician offices and at home. The public understands their tremendous utility. We're really interested in ensuring that key message from the pandemic – using all tests across all modalities, be they lab-based, point of care, at-home, or OTC – carries forward in policy.

We're looking forward to working with regulators to ensure that we capture the lessons learned from this moment in time as we set a policy pathway that allows us to get testing to more consumers much more readily. We're really enthusiastic about that prospect.

Rick Bright, Ph.D.

I spent billions of dollars as BARDA director trying to make better vaccines and drugs, and better ways of delivering them. And yet we've failed repeatedly to meet the moment when there's been a viral outbreak because we didn't detect it soon enough. So I shifted our strategy to also invest in diagnostics and to get them integrated into our daily life.

But I believe that one of the greatest gaps in our knowledge is an ability to capture early warning signals. Imagine if in early 2020 we were able to detect people fleeing Wuhan. What if we were able to see emergency room parking lots filling up in an uncharacteristic way? What if you could splice that data with clinical data or biological data? The world is full of data. How do we access it, connect it and share it so we can have a greater global perspective on what's happening around us and around the world?

The Pandemic Prevention Institute is building a platform called GeoSeeq. It's a global expandable observatory that will allow us to organize different types of data from all over the world. Metadata that tells us valuable information about where the sample came from, what their background clinical experience has been, whether they're vaccinated or unvaccinated. Is the virus in their nose a new variant? Does that mean something impactful? What is the phenotypic or biological characterization? Does it spread more easily? Is it more pathogenic? Can it evade the vaccines or therapeutics we have?

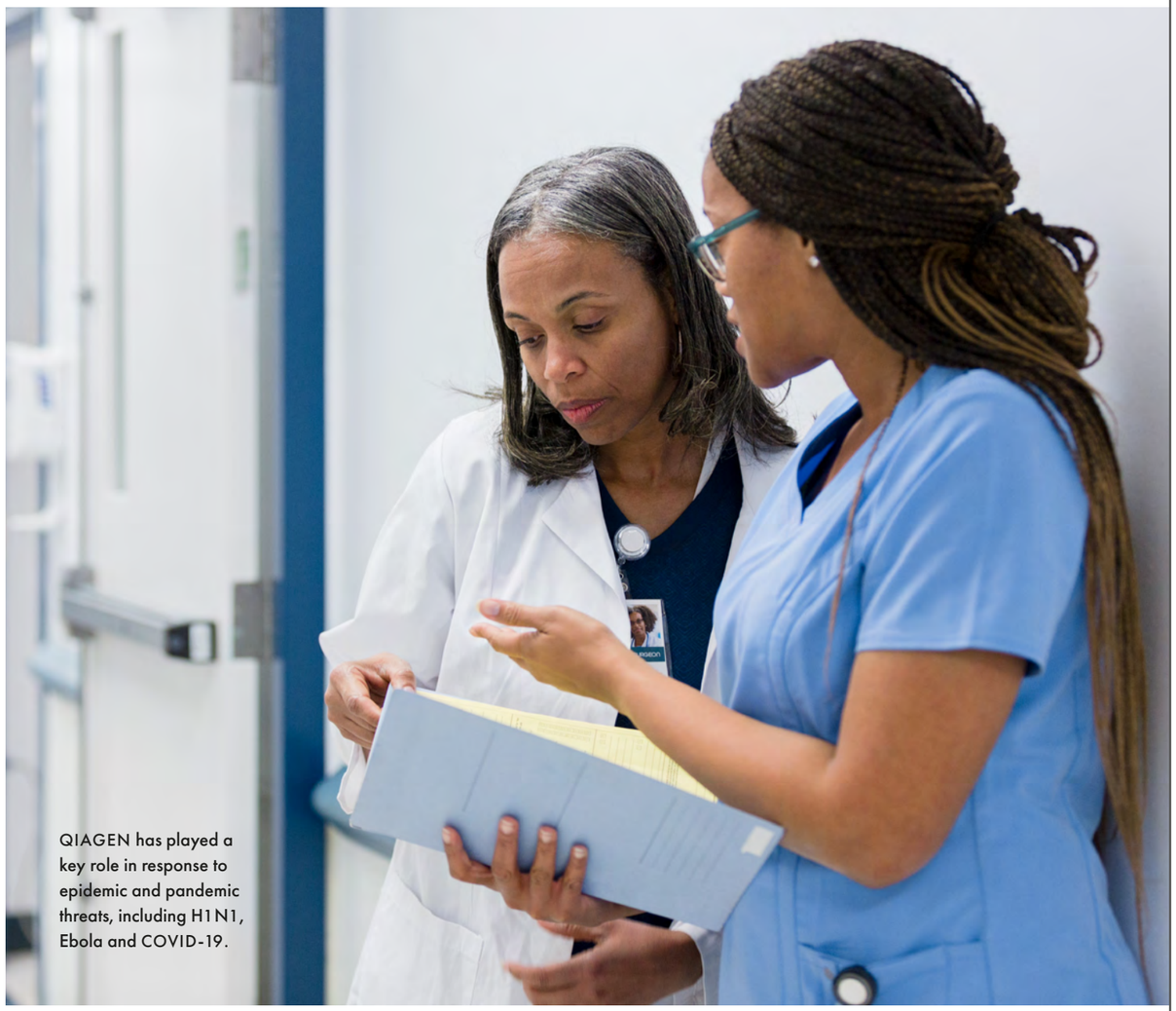
None of those data are connected within any U.S. state, across the U.S., or anywhere in the world. And they're all over the place – different languages, different formats, different standards. We can connect those who generate data in a universal platform and architecture that can ingest and/or connect different types of data, and then collate it, compile it, and analyze it with modern methodology.

We must ensure data that are shared are de-identified to respect the privacy of the individual. And in some countries, they don't want to put their data in a database. The platform we're building will allow us to connect to and collaborate with other databases without having to ingest or move the raw data. Most of the world doesn't have access to that sort of system, so we're working with local communities to bring them modern analytical tools and help them build the tools that they want to address needs in their local communities.

We could choose the seasonal influenza vaccine model for Coronavirus and always be chasing our tail, or we can grab onto the technologies of 2022 – the databases, the analytical tools, the synthetic vaccine tools we have now with mRNA, and virus vectored vaccines – and study the constraints of the virus and our immune responses to synthesize an antigen to make a broadly reactive immune response. We can get in front of all coronaviruses. We can do that now.

"The world is full of data. How do we access it, connect it and share it so we can have a greater global perspective on what's happening around us and around the world?"

Rick Bright, Ph.D.
CEO, Pandemic Prevention Institute, The Rockefeller Foundation
Former Director of the Biomedical Advanced Research and Development Authority (BARDA), a division of the U.S. Department of Health and Human Services



QIAGEN has played a key role in response to epidemic and pandemic threats, including H1N1, Ebola and COVID-19.

"I think pandemic preparedness is really confusion preparedness. It's navigating the confusion that usually hits in the first 100 days of an emergency.

Davide Manissero, M.D.
Chief Medical Officer, QIAGEN

Davide Manissero, M.D.

COVID-19 has been the first real pandemic for QIAGEN. Swine flu and avian flu were pandemics from an epidemiological standpoint because there was transmission on every continent, but from a clinical and public health standpoint, they never reached the magnitude of COVID-19. For those, we did pandemic preparedness. For COVID-19, we did pandemic response.

I think pandemic preparedness is really confusion preparedness. It's navigating the confusion that usually hits in the first 100 days of an emergency. Relationships are key to that. Actually, the relationships we developed through our work with TB have had value in the current pandemic, and also in our understanding of preparedness. For example, we established direct lines with the WHO and public health institutes in different countries. That helped us to move much faster with COVID-19.

But they need to be organized to give systemic advice to companies and aim them in the direction that's needed to avoid confusion. So to me, what's important for the future of pandemic preparedness is changing the way we communicate with public health authorities. That is a missing link that we need to fulfill.

Data relationships were important too. We used open-access data on GISAID that had been uploaded by Charité and other institutions around the world to develop our first assay. By Christmas of 2019, we had a SARS-CoV2 assay design that eventually became the QIAstat-Dx.

So what is QIAGEN offering from an open access standpoint? We run a daily batch of the sequence we've chosen for our assay against every single sequence on GISAID, which is about ten million now. We began publishing this on our website very early on in the pandemic – at first every two weeks, and now every month. We also published the methodology in a peer-reviewed paper. These results are available to the public and to regulators.

It's unprecedented for any company to publish the post-market surveillance of their assay. It's more familiar in pharmacovigilance, where they monitor adverse events. What we monitor is the loss of accuracy of our test. To me, this is a big step forward.

We developed relationships with institutions like the Rockefeller Foundation that deals with surveillance and preparedness. We were one of the first companies to bring a wastewater surveillance device purely for COVID-19. It's a very limited market, but I think it's our corporate duty to contribute to that. How can we marry the market need with the public need? We want to ensure this can be extended to monitor any new emerging pathogen.

James Connelly

CEO, My Green Lab

The building industry accounts for nearly 40 % of total global carbon emissions – driven by both the operational energy of the buildings that we work and live in every day and the carbon impact of creating, transporting and installing the materials that go into our buildings. Laboratories are some of the most resource-intensive buildings of any kind. Only data centers and certain types of specialized factories use more energy than a research lab.

Plug loads make up a significant amount of energy consumption in research laboratories because there's a density of equipment, including freezers and other types of specialized equipment like autoclaves. Even things like centrifuges, shakers and biosafety cabinets have significant energy consumption – and unfortunately, people tend to leave this equipment on 100 % of the time. A lot of energy can be saved by just turning off the equipment when it's not in use.

Another huge driver of energy consumption in laboratories is ventilation. Of course, you need to ventilate when you're working with potentially harmful chemicals or need to keep a sterile environment. But researchers can make simple changes, like closing the fume hood and making sure to only keep the equipment on when needed, that have a significant impact in driving down energy consumption.

Autoclaves are often the single biggest consumer of water in a lab building. In the quenching cycle, when cooling down the ejected exhaust steam, older autoclaves will simply have cold water running down the drain pipe at all times – even if not in use. Autoclaves can use up to 50 million gallons of water over their lifetime! However, installing a water miser to make sure that you're only quenching the pipes when the autoclave is in use can make a dramatic difference in water consumption. So can using your autoclave sparingly – only when it's full, and with the energy-saving features on. Selecting more efficient equipment makes a big difference too.

There are also simpler sustainable best practices, such as ensuring that you have low-flow aerators on your sinks and use 100 % purified distilled water only when it's required – because it takes energy and water to produce. Alternatives to single-pass cooling like an air-cooled condenser can also drive water savings.

My Green Lab Certification employs a proven process of continuous improvements that empowers scientists and those who work in the lab to build a lasting culture of sustainability. Most companies will have high-level goals around sustainability, waste reduction or energy reduction, but people in the labs don't often know what those goals are or how to take action at the bench. The My Green Lab Certification framework helps them do that in a meaningful, measurable way. The program has now certified more than 95 labs in 30 countries. A huge amount of that growth has been in the last two years, in which we've certified over 600 labs.

In labs we've evaluated, we've seen up to 30 % reductions in energy, 70 % reductions in water, and a 10 % reduction in waste. However, it really depends on the baseline that lab is starting at and the type of research they're doing. Every lab we work with has an opportunity for savings, and the potential for change is only limited by the creativity and courage of each individual to challenge the status quo and improve the efficiency of their work.

Caroline Metzen

QIAGEN Application Specialist and Sustainability Ambassador

As a kid I helped my grandfather a lot in the garden, and in return he taught me all he knew about all the plants and critters. This is partly why I developed such a strong interest in nature, and today my heart is still devoted to environmental and animal protection. I hope that wildlife suffering due to our unsustainable consumption and poor recycling will soon belong to the past. But that will never happen unless we take concerted action, now.

Life science laboratories around the world created 5.5 million tons of plastic waste in 2014. I visualize this by picturing an art installation in a canal in Bruges, Belgium. It's a five-ton whale made entirely of plastic. Now imagine a million of those whales being produced every year!

Water and energy use in labs is equally high. They're needed for almost all processes, such as sample preparation and analysis, autoclaving lab waste, washing reusable material, sustaining ULT (ultra-low temperature) freezers, and much more.

Changes need to be made in labs worldwide to make science more sustainable, and recycling waste is an easy first step. We started in Hilden a few years ago. We bought plastic-reduced pipette tip boxes from our supplier, which then took them back for recycling. I also set up a bin to collect non-contaminated aluminum foil from our labs. Other QIAGEN labs joined in through our local sustainability team to implement practices like glove recycling, the reduction of single-use items like overshoes, switching to rechargeable batteries, and using "recyclate" waste tubes made from 100 % recycled plastic that would normally be thrown away during standard production. We also increased the temperature of our ULT freezers from –80 °C to –70 °C to reduce energy consumption.

The next big step for our labs will be our cooperation with My Green Labs and achieving the Green Lab Certificate. This change will not only make our lab more sustainable, but also show other QIAGEN sites and our customers that changing into sustainable laboratories is possible.

Outside of work, I try to do the best I can to be sustainable. I collect trash during my walks with my dog, Mila. My favorite quote, by the Zero-Waste Chef Anne-Marie Bonneau, sums it up perfectly: "The world doesn't need a few people who do sustainability perfectly, it needs a million people doing it imperfectly."

Tackling the lab waste challenge

Laboratories have a waste problem. Every day they go through large quantities of single-use plastic. This is seen as an unavoidable consequence of safety and hygiene regulations. But more and more, people in the industry have begun to ask if there is a more sustainable alternative. QIAGEN now has some of the answers with a new line of extraction kits that can help reduce lab waste.

Andreas Hecker, Ph.D. is Senior Global Product Manager, responsible for the QIAwave product line. The idea was born out of his desire to reduce plastic waste both at home and in his professional life.

Improving sustainability doesn't happen overnight – it requires new ideas, new materials and changes in behavior. All of which can be especially challenging in a highly regulated industry like biopharma, where strict regulations are needed to ensure diagnostic and healthcare products are sterile. The result is approximately 30,000 tons of single-use products landfilled or incinerated globally every year.

There is, however, an appetite for change, as Inga Irle, marketing manager, and Andreas Hecker, product manager for QIAGEN's new QIAwave product line, found out. Both are driven by a commitment to improving sustainability and have contributed to the company's steps toward this goal. They know how challenging it can be but weren't deterred from thinking big. Sometimes it just takes an impulse to get the ball rolling.

Instigating change

"Everything changed for me when the pandemic started," says Hecker. "During the first lockdown, my wife and I started to rethink our behavior in terms of our impact on the environment. We wanted to reduce the amount of waste we generated, so we started to get our groceries from stores where you can buy dry goods without packaging."

It was the beginning of a journey that evolved over the following months. "We found it takes a lot of effort to change your behavior," he says. "It's so convenient to go to the supermarket. But slowly we've started to change our habits and adapt to this new style of shopping."

Once Hecker had seen that change was possible in his private life, he turned his attention to work. "I thought, how can we translate that to QIAGEN? We were already working on plastic reduction, but I wanted to see if we could drive it further," he says. "We started to talk to customers, and many were open to exploring ideas that could reduce our impact on the environment as an industry. So this is when the idea for QIAwave arose."

Single-use disposable plastic has long been accepted as an unavoidable part of laboratory work, especially in the tightly regulated molecular diagnostics space. But scientists, businesses and research institutes are now looking for ways to minimize its use.

"Storage space is an issue in every lab. By designing out the excess, we've improved sustainability and helped our customers."

Inga Irle, Ph.D.

Senior Strategic Marketing Manager, QIAGEN

"We've seen a big change in mindset within our industry. Sustainability is going mainstream."

Andreas Hecker, Ph.D.
Senior Global Product Manager
QIAGEN

Working out what will work

QIAwave is a new line of nucleic acid extraction kits that use fewer components and produce less waste than existing ones. The QIAwave RNA Mini Kit, Plasmid Miniprep Kit and the DNA Blood & Tissue Kit use up to 63 % less plastic and up to 42 % less cardboard compared to our standard kits.

These results were achieved by looking at every material and component and asking if there was a feasible, more sustainable alternative. The Waste Tubes, for example, are made from 100 % recycled plastic, and the chosen buffer being more concentrated than standard buffers allows it to be transported in smaller bottles.

Unlike other initiatives at QIAGEN to reduce waste, this involves not only new ideas and new materials, but also new behavior. "Our ready-to-use kit concept is what has made us a success," says Irle. "QIAwave is slightly different. With the buffer concentrate, for example, additional steps are required before you can use the product. But we see that our customers are prepared to accept this to become more sustainable."

Collaboration creates innovation

To ensure the idea would work, Hecker and the team involved customers at an early stage, carrying out customer surveys and observation. "We literally looked over the shoulders of our customers as they did nucleic acid isolation," says Hecker. "From that, we could see what we could change. We came up with the new designs, tested them, and then asked our customers to what extent they were willing and technically able to adapt their behavior. The majority were very open to change."

Of course, there were challenges. There were some concerns about recycled plastic coming into contact with samples. The team overcame this by making the QIAwave recycled plastic Waste Tubes in a different color so that they stand out.

QIAwave is a portfolio of products offered alongside QIAGEN's existing range. This gives customers a choice. Irle and Hecker believe that many will choose the more sustainable option over our standard kits, given that many of QIAGEN's customers are making environmental commitments of their own.

The beginning of a journey

Becoming more sustainable requires considerable effort, but every change makes a difference. The smaller the kit box, the more kits can be fitted on a pallet, and that translates into fewer trucks and fewer emissions from transport.

It can also bring other benefits. "Storage space is an issue in every lab. There's never enough of it. So, in this sense too, QIAwave is a game-changer," says Irle. "By designing out the excess, we've improved sustainability and helped our customers solve one of the constant challenges of lab work."

To enable customers to calculate how much waste they save annually by switching from our standard kits to our QIAwave Kits, the team has developed an online tool. And this is only the beginning. "We're working on more improvements," says Hecker. "We've seen a big change in mindset within our industry. Sustainability is going mainstream."

Irle and Hecker's advice for anyone else looking to improve the sustainability of their products: "Question the status quo of each and every material. Ask yourself, why is it made like that and is that really necessary," says Hecker. "And don't aim for a 100 % solution at the beginning. From status quo to an ideal world takes many steps. Dissect your project into pieces that are achievable within a defined period of time. Then you know you're going in the right direction, and it will evolve over time."

Inga Irle, Ph.D. is Senior Strategic Marketing Manager for QIAwave. She is impressed by the adaptability of customers and colleagues to help to improve sustainability.

QIAGEN Footprint

>6,000

passionate QIAGENers around the world

100 %

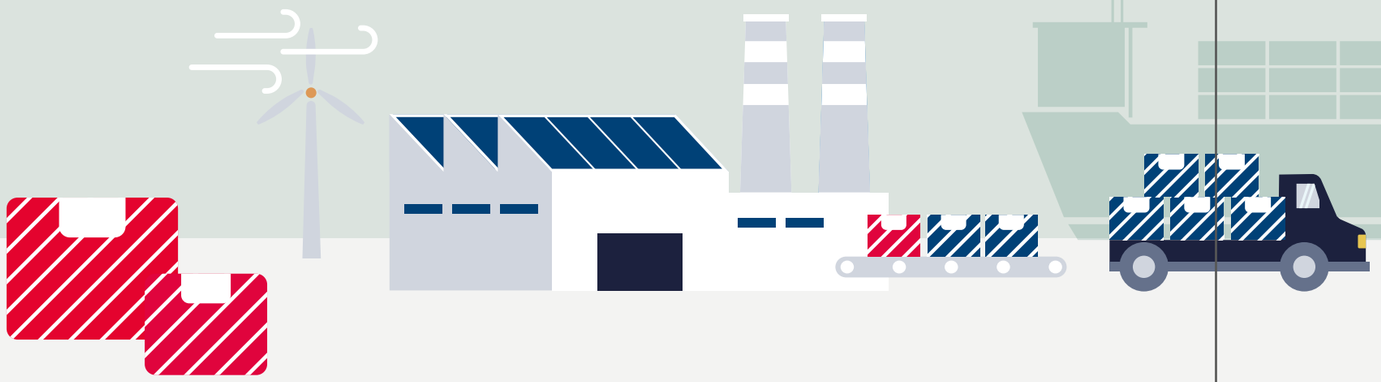
Suppliers committed to sustainable improvement goals by 2023

Carbon neutral goal by 2050

2030 interim goals: 40 % reduction in Scopes 1 and 2, 10 % reduction in Scope 3

$2.2 bn

sales in 2021



Research and development
To build sustainability into our business, the environmental and social impact of a product needs to be considered at the product conception and development stage. This is how our QIAwave and QIAreach products came into being.

Suppliers
We will work with our suppliers to help them reduce their environmental footprint.

Some of our suppliers are already embracing the circular economy model. For example, Pöppelmann uses its waste plastic off-cuts to produce plant pots.

Manufacturing and operations
At our main manufacturing site, we purchase only green energy, and in 2021 we installed solar panels. We have plans to move our other sites to green energy in the near future.

Packaging
Our products often need to stay at a low temperature during transport around the world, which means using appropriate packaging.

In 2020 we switched to eco-friendly cold supply chain packaging, reducing our secondary plastic transport packaging by 9.6 %.

> 6,000 QIAGENers globally in 38 premises, including 9 manufacturing sites.

Delivery
With a global customer base, our products need to reach people all over the world. We use a combination of road, air and sea freight.

33,062 tons of CO_2 equivalents were emitted for the transportation of materials and products in 2021.

Customers
Our customers are researchers and clinicians like Tim Mousseau (page 60) and Rose Herrera (page 30), who are working on solving scientific mysteries, researching new methods of treatment, and simply making the world a better place.

Recycling and disposal
Disposable plastics and waste are still a major problem in the life sciences and healthcare industries. To help our customers with responsible disposal of our products, our recycling card outlines the composition of the components of our kits.

We serve > 500,000 customers in 70 countries.

Fighting the stigma

The key to eliminating TB

After surviving an earthquake, Rosa Herrera, M.D. thought the worst was over, but she had contracted tuberculosis after sheltering in a crowded ER with patients and other residents. It took her 10 months to recover physically from the disease, but the emotional strain of the stigma that comes with the illness was especially difficult. Now, Herrera is doing all she can to reach out and treat the hardest hit communities.

"We already know that TB is a highly preventable and 100 % curable disease. It's so important that the survivors share their experience so other survivors raise their hands and say, I have it too, and you can survive through this and we can be supportive of each other."

Rosa Herrera, M.D.

Mycobacteriosis Program Coordinator, Mexicali Institute of Public Health

Rosa Herrera, M.D.
is a mycobacteriosis program coordinator for the Mexicali Institute of Public Health

When a strong earthquake hit Mexicali on Easter Sunday in 2010, one local hospital emergency room became a refuge amid the chaos. Residents and patients, relocated from their rooms, crowded into the space with the staff, who were simultaneously caring for everyone and attempting to stay safe. Rosa Herrera was one of them. Then a 25-year-old intern, she thought the worst was over. She'd survived the earthquake uninjured. Instead, the worst was just about to begin. Over the next four months, she increasingly had trouble breathing, and she was exhausted all the time. She blamed her symptoms on her grueling schedule as a young emergency room doctor-in-training working in a bustling city on the U.S.-Mexico border, who had little time to rest or eat properly. But when one of her patients, a woman in labor, pointed out that Herrera couldn't walk more than two or three yards without stopping to catch her breath, she finally admitted to herself that something was clearly not okay. A chest x-ray revealed a pleural effusion across her right lung.

"I immediately knew I had tuberculosis," she recalls. She'd contracted the disease from someone sheltering in the emergency room after the earthquake. It took her almost a year to recover physically from the disease. She had complications from surgery, adverse reactions to treatments and "a huge lack of diagnostic tools."

Dealing with the stigma surrounding the illness was even harder to bear. Her family avoided her completely. "That caused so much pain for me," she says. "It was so lonely ... not to be with all my family. Only my mother took care of me. I was isolated and alone in my room for a month. It was really difficult." Even her medical colleagues kept their distance well after she could no longer have been contagious. "They were asking me to wear a mask even when I was not contagious," she says. "During this time, I realized what it is like to be a sick person, and what the challenges are that we have to face." So intense is the shame connected to having TB that even though she'd contracted it while healing other people, it took her eight years to openly admit that she'd once had the disease, which kills more people every year than any earthquake ever does.

Now Herrera, a mycobacteriosis program coordinator for the Mexicali Institute of Public Health and the mother of two young children, uses her TB experience as motivation to help fight the disease – and the stigma. And she has the tools to do so in even the hardest-to-reach communities.

Lack of empathy and diagnostic tools

A Mexicali native, Herrera learned a lot from her time in recovery. She altered her course of study to focus on TB and says that although she "suffered through hard times" as a patient, "they taught me a lot about the importance of being empathetic, and how that support gives the patient the opportunity to get the

cure, or finish their treatment. And it showed me first-hand how people are not really well educated about the disease." Knowing that even friends and family can react so severely when they find out you have TB is one of the challenges in encouraging patients to get tested.

"There's not only this stigma when it comes to talking about the disease," she says, "but also to talking about the stigma itself, or the situations you have to face. There's no shame in getting tested and treated, since treating latent TB is simple. Much simpler than dealing with the risk of getting sick and infecting others." Herrera now works with the Zero TB Initiative's mobile unit to reach those communities that not only need educating about TB, but testing and treatment for it too. One of largest groups vulnerable to TB in Mexicali are drug abusers and the homeless population, who have the highest incidence of both active and latent forms of TB, with about 3,000 cases per 100,000. "When you have this disease together with having a drug problem, it's really hard to look after yourself," she says. "You're only going to receive health care when you're severely ill. So that means they've been contagious for a long period of time before they get treatment and may have infected a lot of people during that time – it can be extremely challenging."

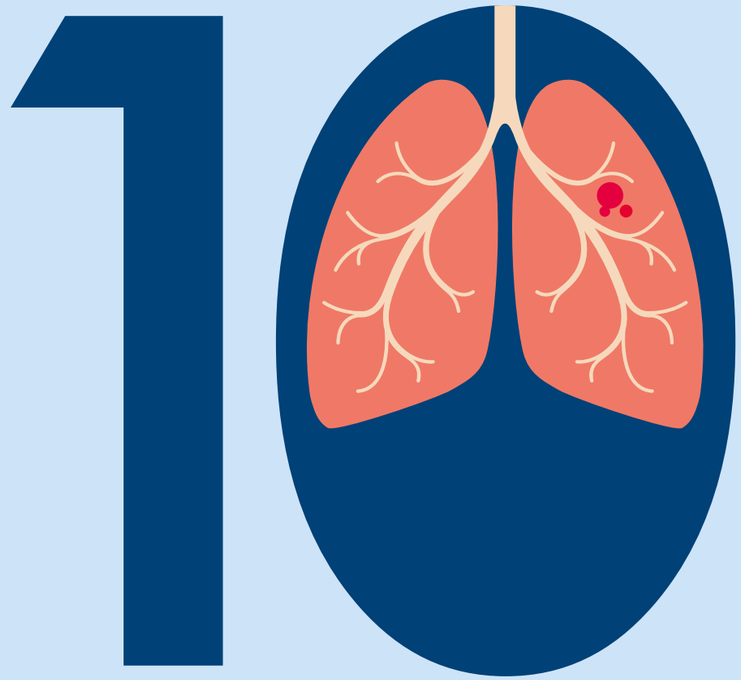
Quicker tests mean quicker treatment

She now has a new tool at her disposal: the Q1Areach QuantiFERON-TB Test, which was specifically designed for high-TB-burden countries like Mexico that don't always have access to complex testing labs. Unlike traditional TB skin tests, which require two visits, the QuantiFERON-TB test is a field-friendly, single-visit AGRA test packaged in a handheld device. An incubated blood sample is placed on an E-stick, which is inserted into the E-hub. It gives digital results in less than 20 minutes. It can handle up to eight samples at once. The QuantiFERON-TB test offers similar accuracy to other TB blood testing methods but is much more accessible. "It's portable, you don't need to invest a lot

A major benefit of blood tests like QuantiFERON is that they replace the TB skin test, a 100-year-old method with hit-or-miss accuracy.

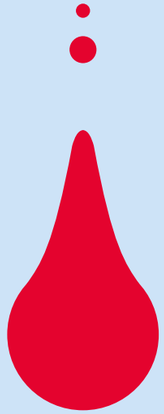
Over the past 15 years, laboratory-based TB interferon gamma release assays (IGRAs) have been transforming screening programs with higher accuracy, operational advantages and improved convenience. QuantiFERON technology has been the subject of over 1,500 clinical and scientific studies.

QFT-Plus uses an IGRA to measure the T-cell immune response to MTB and provides the convenience of a single patient visit with electronic reporting, quantitative results and high accuracy. It is endorsed by the WHO, embraced by the UN and IPPA, and is among the WHO's 120 essential diagnostic tests.



10

million people
contracted TB
in 2020 –
1.5 million died.



"With QIAreach you only need one visit, one tube and one milliliter of blood, and you'll have accurate results in 20 minutes."

Rosa Herrera, M.D.
Mycobacteriosis Program Coordinator
Mexicali Institute of Public Health

Early detection of a TB infection with IGRAs like QFT-Plus can help reduce the course of treatment by enabling earlier intervention and prevent TB from developing into a drug resistant version that is much harder to treat.

of money," Herrera says. "So we can envision making these tests available in communities where the resources are pretty low."

The test also eliminates the need for a second visit. "We can diagnose the infection and we don't have to go back – we can take action immediately because the test result is ready in 20 minutes. We don't need a lot of staff or to invest in extra resources, and we don't need cold storage, which is a big point in a place like Mexicali – it can get up to 50 degrees (120 °F) in the summer." A single visit is particularly important in a place like Mexicali because, Herrera explains, "we have lost the follow-up on several patients who for various reasons can't show up for a second visit." Also, with a TST test "it's really hard to ensure we're going to come back 72 hours after the first application. If the staff aren't well trained, you won't be sure the correct duration between visits is properly observed." With QIAreach "you only need one visit, one tube and one milliliter of blood, and you'll have accurate results in 20 minutes."

We can eliminate TB

Medical staff on the tuberculosis frontline need all the help they can get. TB cases have surged in many countries over the past two years as the world focused on preventing and treating COVID-19 infections. Herrera believes that the international response to SARS-CoV2 is evidence that, when humanity puts its mind to a problem, it can find a long-term cure. After all, for COVID-19 it came up with multiple vaccines in just one year. She wants the same kind of collective effort aimed at TB.

"We already know that TB is a highly preventable and 100% curable disease. It's so important that the survivors share their experience so other survivors raise their hands and say, 'I have it too, and you can survive through this and we can be supportive of each other.'" She continues, "It is so clear that we need to put our resources together as we have done with COVID-19, and maybe if we do something with that amount of effort, we could really eliminate tuberculosis ... We'll change history, and we'll save so many millions of lives."

Perspectives

As the nature of the pandemic has changed and with promising COVID-19 treatments becoming available, it is difficult to decide when and how to use the different kinds of tests available. How are labs deciding how to test? And why is continued testing so important? Three experts in the field, from three very different parts of the world, describe their experiences.

Perspective 1

Dr. Allison Glass
is a clinical virologist and head of molecular pathology at Lancet Laboratories in Johannesburg, South Africa. Her lab was the first to discover the Omicron variant.

The race to get results

Early in her career, clinical virologist Dr. Allison Glass was a neurosurgical medical officer in emergency medicine who thrived on the adrenaline rush of quickly stabilizing a patient. Today she's an ultrarunner whose favorite race is the 89-kilometer (56-mile) Comrades Marathon.

But nothing really gets her heart – or her mind – racing like viruses. Glass is Head of Molecular Pathology at the Johannesburg branch of Lancet Laboratories, a private pathology practice with more than 200 hospital labs and depots across South Africa. The lab processes tests for infectious diseases, oncogenetics and genetic diseases, along with paternity testing and other services.

The main challenge in today's pathology lab compared to 20 or 30 years ago, Glass says, is that because lab results provide an objective diagnosis, doctors rely on them for management of their patients – and they need accurate answers fast. "We're able to give the doctors their results so that they can manage their patients quickly and effectively."

The company acquired its first QIAstat-Dx platform in early 2020 and has since placed platforms in 12 hospital labs. "We're of the opinion that molecular testing, especially for infectious diseases, needs to move closer to the patient," Glass says. The QIAstat allows them to handle more samples locally and immediately without batching or needing to send them to Johannesburg "It cuts our turnaround time down by at least 12 hours."

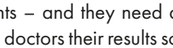
They especially rely on the respiratory virus and gastrointestinal panels. "Syndromic testing is really important because multiple different bacteria and viruses might cause exactly the same symptoms," says Glass. "From an infection-control and a treatment point of view, it's really important to know the cause. Otherwise, a patient may have to undergo a lot of testing, remain in the hospital longer or receive unnecessary treatments. All of that negatively impacts the patient outcome and increases the cost of care."

The QIAstat's automated processes limit human error and exposure to pathogens and are accessible to technicians with good basic lab practices. "They don't need to be specifically molecularly trained to use this platform," Glass says. "In a country where molecularly trained staff are not always readily available, this is a really handy and very useful way to get molecular testing spread out across the country."

She also appreciates its compact size. "It's really an excellent little machine for use in a hospital laboratory. It's got a very small footprint. You can usually find a corner of a workbench to put it on."

The Sars-CoV-2 variant Omicron was first identified in a Lancet lab in Pretoria. With case numbers exploding, rapid diagnosis became essential. "The QIAstat offered us the advantage of being able to give the doctor a quick COVID result by running the respiratory panel onsite at the hospital. So we can prioritize the very urgent patients on those platforms while we send the large bulk of routine work to the main lab," says Glass.

Glass sees one potential positive outcome from the pandemic – lower-cost molecular testing. "COVID has contributed to a ramping up in production of molecular testing capabilities and capacity, bringing costs down," she notes. "It's really my hope that in the next few years, the cost of molecular testing will come down further so that it's more accessible to a broader range of people."



The QIAstat-Dx Analyzer, combined with QIAstat-Dx assay cartridges, surveys multiple pathogens in human biological samples. The QIAstat-Dx Analyzer runs ready-to-use cartridges that include all the reagents on board, allowing for hands-off sample preparation.

Whether she's running an ultramarathon or a state-of-the-art molecular testing lab, clinical virologist Dr. Allison Glass thrives on fast-paced results.

The QIAprep&amp Kit is an innovative liquid-based approach that combines sample preparation and detection into one kit. Fewer and simpler workflow steps means faster results for labs and less plastic usage and hands-on time.

When the Thai government decided to allow tourists to return to Phuket, they turned to one man to keep it safe: Prof. Dr. Vip Viprakasit, M.D.

Perspective 2

Prof. Dr. Vip Viprakasit, M.D.
is a professor of pediatrics at Siriraj Hospital and the owner of ATGenes, a molecular testing and diagnostic company, both located in Bangkok.

Drawing tourists back to Phuket's beaches with "the Sandbox"

Before the pandemic, the Thai island of Phuket hosted more than nine million visitors a year. One was Bangkok native and self-proclaimed foodie Prof. Dr. Vip Viprakasit, M.D. From its Michelin-star restaurants to its local fare, "Phuket is a food heaven," he says. He especially likes bonding with his 17-year-old son over Hokkien mee noodles or a savory crab curry.

But COVID-19 shut Phuket down, crushing its tourism-dependent economy. In early 2021, the Thai government decided to reopen the island through an experiment called the Phuket Sandbox. "When you have something innovative that nobody has done before, it's like kids that play in a sandbox," says Viprakasit. But a sandbox is also supposed to keep its contents from spilling out. If tourists caused an outbreak on the island, it could be contained.

Fast, reliable molecular testing at Phuket International Airport was the heart of the plan. The Thai Ministry of Public Health turned to Viprakasit for ideas.

A professor of pediatrics at Siriraj Hospital and the owner of ATGenes, a molecular testing and diagnostic company, Viprakasit had just won the Prime Minister's Innovation for Crisis Award for the invention of a mobile biosafety unit for COVID-19 testing. It's a positive pressure cabinet attached to the back of a pickup truck that traps COVID-19 particles, allowing medical staff to stay safe and cool in street clothes rather than PPE, which is unbearable in Thailand's tropical heat.

After Viprakasit donated the prototype to the King Rama X, H.M., the King gave his royal permission for its replication. Soon there were 60 mobile units roaming Thailand.

Parked just outside of arrivals at Phuket International Airport, five of them became key to the Phuket Sandbox, which launched in July 2021. After clearing customs, visitors register with ATGenes, which handles the sample collection and molecular testing for the provincial Department of Disease Control, then head to Viprakasit's trucks for a nasopharyngeal swab sampling. They're then chauffeured to an approved, prepaid hotel to await their PCR test results, which generally come within four hours.

Meanwhile, the sample is walked over to the ad hoc laboratory that Viprakasit and his ATGenes team created at the airport in a modified shipping container. After conducting PCR testing, the lab emails the results to the visitors and to public health officials hours later. Once cleared, the tourists are free to explore Phuket for the next week. If they want to leave for another Thai province, they must first take another PCR test.

The lab has to screen every international flight arrival, which means conducting some 7,500 tests a day. Viprakasit relies on the QIAprep&amp test. "It's the most easy to use and most flexible platform solution," he says. "QIAprep&amp helps us to reduce time of extraction and PCR so we can report the passenger results. Moreover, we don't need an extraction machine, which helps us to save space and money. The lab can run QIAprep&amp with a manual platform and also can use QIAgility to handle sample processing."

Viprakasit also notes the QIAprep&amp's ability to detect variants. "It's very flexible and easy to adapt in the lab," he says.

Omicron caused the government to temporarily suspend the Phuket Sandbox, but it was open again by mid-January. It also expanded the Sandbox to a handful of other cities. There have been "zero outbreaks" of COVID-19 due to tourists, Viprakasit says. "I can say that the success of the Phuket Sandbox is composed of planning and lab ability with QIAprep&amp technology."

On a recent visit to Phuket, Viprakasit was told by a restaurant waiter, who was nearly in tears, that the Sandbox had allowed him to work again and feed his family.

"I thanked him for telling me his story," Viprakasit says. "I know he's not the only one. Phuket Sandbox has a tremendous impact on a lot of people who are really underprivileged, and I'm very proud to be part of that."

Shifting from manual to automatic

In the beginning of the COVID-19 pandemic, the first lab in Michigan to run PCR tests processed around 90 samples a day. By the time Omicron hit, it was processing 2,700.

Linoj Samuel, Ph.D. remembers the exact date his clinical microbiology lab in Detroit's Henry Ford Hospital began running COVID-19 PCR tests: March 16, 2020.

The samples were from patients who'd been hospitalized for pneumonia in one of the six hospitals in the Henry Ford Health System (HFHS), located throughout metropolitan Detroit. It's a 24/7 facility with a staff of 60 that also handles samples from more than 30 HFHS medical centers.

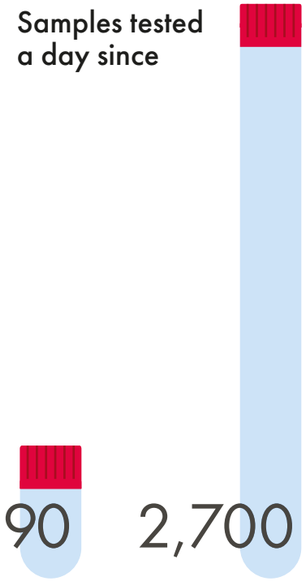
The lab techs pipetted the manual assay recommended by the CDC, completing the first 30 tests in around three hours. They were the first non-public health lab in Michigan to do so. "I remember standing there looking over the shoulder of a lab tech as the first results came in and thinking, 'Wow,'" he recalls. "A significant chunk of that first batch were positive for COVID."

Four days later, they began running out of reagents, nasopharyngeal swabs and viral transport medium (VTM), reflecting global shortages. They adapted and improvised, asking a 3D-printing company in Dearborn, MI, to 3D-print swabs, and hand-filled vials with saline solution as a VTM. They bundled them together in testing kits and shipped thousands of them to the HFHS hospitals and medical centers.

Perspective 3

Linoj Samuel, Ph.D. is a specialist in pathology and the head of the clinical microbiology lab at Henry Ford Hospital in Detroit – the first lab to create COVID-19 testing protocols in the state.

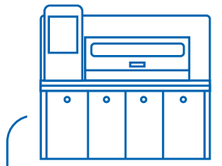
In the beginning of the COVID-19 pandemic, the first lab in Michigan to run PCR tests processed around 90 samples a day. By the time Omicron hit, it was processing 2,700.



"We also had to modify assays on the fly," says Samuel, who is an ABMM (American Board of Medical Microbiology) certified medical microbiologist with a Ph.D. in Microbiology and Immunology from the University of Arizona, Tucson.

As the number of test requests skyrocketed, Samuel thought of the NeuMoDx high-throughput automated PCR platform located in a hospital research lab. "We were able to bring that machine over and immediately put it to use," he says. "I think that was a critical part of our COVID response, especially in the first six months. It was really critical in making sure we weren't just testing patients, but testing providers and clearing them to provide care."

They soon added a second NeuMoDx platform. When Omicron hit greater Detroit in early 2022, the lab processed as many as 2,700 samples a day using six testing platforms and returned 95 % of the results within 24 hours.



As a scalable solution, the NeuMoDx Molecular System can run medium to large numbers of patient samples – ideal for reference labs, hospitals and academic institutions. The easy 3-step workflow results in accurate diagnostic answers to help make quick clinical decisions.

Since March 16, 2020, the lab has completed approximately 750,000 COVID-19 tests. Samuel believes his skilled lab techs are some of the unsung heroes of the pandemic. "You hear about nurses all the time – and more power to them. They do an incredible job," he says. "But I think that most of the country is unaware that there are lab techs behind the scenes with highly specialized training who are working 24/7."

Q&A

QIAGEN's Global Public Health and Global Emerging Markets teams spoke to Insights about how molecular diagnostic tools can even the playing field and address health inequities in low and middle-income countries.

What are the main challenges to diagnosing diseases in low-income regions?

Marc Destito, Vice President and Head of Global Public Health: There are a number of challenges. First and foremost, many low-resource regions don't have complex laboratory infrastructure. Sometimes even getting access to a test can be difficult, particularly if someone lives in a rural area. Funding is also a challenge. Many countries are grappling with resource constraints and have very limited public health budgets or rely extensively on international aid and assistance. As a result, when they have to make trade-offs, they very often prioritize treatment over diagnosis – but treatment only covers half the equation and may not always be the most cost-effective choice if it's not combined with access to rapid, accurate diagnostics.

How are diagnostic tools made more available to them? What is the process?

MD: Regardless of the disease – TB, HIV, malaria, HPV – if they're covered in some way by WHO, UNICEF or any other multilateral organization, there are similar methods. One is direct acquisition from a company. In 2021, QIAGEN's emerging market export team signed long-term agreements (LTAs) with five different UN agencies offering one global price for the products that are included in the LTA. Any low- or middle-income country that procures through the UN system is eligible for the same price, which is very closely pegged to our cost of goods.

A second method is pooled procurement. That's where we work through an NGO that collects orders from various countries and provide them with the products to distribute to their programs and partners around the world. That could be something like the Global Drug Facility, which is part of the Stop TB Partnership. Usually they're low- or middle-income countries that have a high disease burden and are Global Fund eligible.

How are these methods useful?

MD: Many countries don't have the kind of regulatory capacity that the European Union has through the EMA, or the U.S. government has through the FDA. So they rely on the WHO to provide technical guidance and act as a de facto regulatory body, and on NGOs to implement programs on the ground. They also rely heavily on foreign aid and donor funding, such as through USAID and the Global Fund.

How has QIAGEN gotten involved in public health initiatives that incorporate molecular testing?

Simona Grandits, Senior Director, Head of Sales for Global Emerging Markets: The company began building up the public health side of its business around five or six years ago. QIAGEN operates by starting small, building up a local presence and getting to properly understand a region, its needs and the challenges that prevent people accessing medicines and diagnostics.

Marc Destito
Vice President and Head of Global Public Health

Olusola Ogunbowale
Senior Strategic Accounts Manager, Global Exports and Public Health

Simona Grandits
Senior Director, Head of Sales for Global Emerging Markets

We're perceived as a good partner because we're not too big, so we can be flexible and really on top of what we're doing. Funding is, unsurprisingly, the biggest need. For low-income countries, QIAGEN partners with agencies and NGOs that can provide the money. But it also needs to develop products that are not only affordable, but can be used where there's limited technology.

Olusola Ogunbowale, Senior Strategic Accounts Manager, Global Exports and Public Health: Most importantly, when we go to the agencies, we're able to bring down the prices because there are no middlemen. For example, with the QIAreach® QuantiFERON®-TB for TB: this handheld, battery-operated, portable device offers ultrasensitive digital detection of TB but requires far less lab infrastructure than standard tests, making it ideal for high-burden, low-resource settings where patients just didn't have access before. The final cost to the countries is something like $15 per test, instead of $100 or more.

Or careHPV, the world's first molecular diagnostic tool to screen for high-risk HPV in low-resource settings. 80 % of new cervical cancer cases and deaths occur in the developing world. In Nigeria, where I'm originally from, I have sisters and female friends who can't afford the cost of cervical cancer screening. The usual cost of HPV screening is $150 in a country where 40 % of the population still lives on less than $1.90 per day. CareHPV is a far more affordable alternative to standard cervical cancer screening, and it can be used in parts of Africa and South East Asia that in some cases won't have access to electricity or running water.

SG: CareHPV is the most inexpensive HPV test but also the most manual one, so this is where rural areas can really benefit. We can run it outside the laboratory and get great results.

What are the biggest disease burdens in global public health?

OO: TB, HIV and malaria, and then of course COVID-19 came along to make it three plus one. When it comes to testing generally, most agencies want to work with the magic number – below $10 per test. We try to make it affordable for them. We're not trying to make a profit.

Innovative solutions are needed to ensure access to affordable diagnostics to help prevent and treat diseases. For high-burden, low resource countries, in particular, early detection can significantly lower therapeutic costs and stop further spread of infection.

"Why should we offer people a lower standard of care in a low-income country? We should be endeavoring to provide people with the same standard of care regardless of where they live."

Marc Destito
Vice President and Head of Global Public Health

There is a lot of molecular testing inequity around the world. What is the impact?

MD: Let's look at TB. In high-endemic countries like India, some people ask whether we should even test for TB because the probability is that if you find a TB case in one house, everyone in the house should be treated. Don't waste resources on tests, they say. But we would never do that in the United States or Europe. We always test to confirm. Access to healthcare and to testing is a right. Why should we offer people a lower standard of care in a low-income country? We should be endeavoring to provide people with the same standard of care regardless of where they live.

SG: COVID-19 of course provided the world with the starkest reminder of its health inequalities. One glaring example was when the Nigeria Centre for Disease Control (NCDC) was reduced to making a public plea on Facebook because the country couldn't get a hold of extraction kits.

OO: My friend said to me, 'Did you see what the head of the NCDC is saying?' So I contacted the NCDC and said, "We can supply you – please contact UNDP and the Global Fund." We then provided them with about 3 million tests.

SG: We were the first company to supply Nigeria with COVID extraction kits. I was so proud that we'd executed what we'd said we'd do.

OO: We made a real impact because we made the decision that even though there was such an extreme demand, no country was going to be left behind. We were giving each country a consistent volume every month, and it made a huge difference. Because of that, the public health agencies started looking at QIAGEN and seeing that we did something different from the bigger companies.

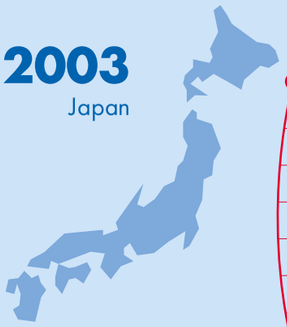
MD: I think messages around ethical and equitable testing are beginning to resonate.

SG: QIAGEN is really a player in public health now. We have high-quality products, and it's in all our common interests to offer good quality solutions to regions that can't normally afford them. I see how the mentality of colleagues is changing – today when I say something's for public health, everyone starts to contribute. You change the culture and the way people think.

The global legacy

of decoding the human genome

2003
Japan



BioBank Japan
One of the world's largest and earliest disease biobanks with samples from more than 260,000 patients. More than 500 papers have been published based on BBJ's samples, including omics analyses revealing links between genes and diseases, as well as physical traits and biomarkers. Some of that data went into the GEM Japan Whole Genome Aggregation, an open-access variant frequency panel of 7,609 Japanese whole genome sequences.

2008
Korea

Korean Genome Project
Aimed at understanding Korean genetic diversity, the initiative started with a single genome – that of cancer researcher and subject Seong-Jin Kim – and by 2021 reached 10,000 sequences through Genome Korea in Ulsan. The goal is to sequence every Korean in the world – more than 85,000,000 people.

2010
Africa

H3Africa, 2010
The Human Heredity and Health in Africa consortium consists of 51 African projects that include population-based genomic studies of heart disease, renal disease, tuberculosis, pediatric HIV, trypanosomiasis, glaucoma and Alzheimer's.

2011
United States

United States
The Million Veteran Program investigates how genes, lifestyle and military exposure affect health and illness. Some 100,000 sequences of the 850,000 veterans who enrolled in the project have so far revealed genetic links to conditions like PTSD, anxiety, breast cancer, heart disease, depression and opioid sensitivity.

2018
Saudi Arabia

Saudi Arabia
In a country where cosanguinous marriages have led to a higher frequency of genetic conditions, the Saudi Genome Project aims to build a genetic database of 100,000 sequences. The nearly 57,000 sequences completed so far have revealed 3,000 novel mutations connected to 1,230 genetic disorders.

2018
EU/UK/Norway

1+ Million Genomes Initiative
This collaborative European Commission project includes 22 EU countries, the UK and Norway and aims to complete one million sequences by the end of 2022. Each country generates a national genomic reference dataset based on their own national population cohort.

T

The Human Genome Project launched in 1990 with the aim of revealing the genetic blueprint of a human being. Over the next ten years, scientists sequenced a series of increasingly complex organisms on their way to decoding us. The first was the bacterium Haemophilus influenzae in 1995. After that came a single-celled, thermal vent–loving eukaryote; the fungus baker's yeast; a transparent and sometimes hermaphroditic nematode; the small, flowering Thale cress plant; every early lab researcher's familiar, Drosophila; and finally, in February 2001, us, when both the International Human Genome Consortium and Celera Genomics published sequences.

Francis Collins, then director of the National Human Genome Research Institute in the U.S., described our revealed genome as "a history book – a narrative of the journey of our species through time. It's a shop manual, with an incredibly detailed blueprint for building every human cell. And it's a transformative textbook of medicine, with insights that will give health care providers immense new powers to treat, prevent and cure disease."

Thanks to advances in next-gen sequencing, it now takes less than a day to sequence a genome, and as a result, large-scale genomic studies are now underway all over the world. Some have a broad view, looking to gain insights into an entire nation's genetics. Others are more targeted projects aimed at specific diseases or populations. While they're all works in progress, some have already capitalized on the early promise of the Human Genome Project, revealing essential details about the genetic underpinnings of health and disease. Here are some notable initiatives.

2008
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One of the world's largest and earliest disease biobanks with samples from more than 260,000 patients. More than 500 papers have been published based on BBJ's samples, including omics analyses revealing links between genes and diseases, as well as physical traits and biomarkers. Some of that data went into the GEM Japan Whole Genome Aggregation, an open-access variant frequency panel of 7,609 Japanese whole genome sequences.

2015
Brazil

Brazilian Initiative on Precision Medicine
BIPMed has two databases containing pooled variant information from which researchers are attempting to gain a deeper knowledge of a range of conditions, including epileptic encephalopathies, craniofacial anomalies, breast cancer, beta thalassemia, hereditary hearing loss, neurofibromatosis and tuberous sclerosis.

2018
EU/UK/Norway

1+ Million Genomes Initiative
This collaborative European Commission project includes 22 EU countries, the UK and Norway and aims to complete one million sequences by the end of 2022. Each country generates a national genomic reference dataset based on their own national population cohort.

2012
England

Genomics England
The last genome in the UK's 100,000 Genome Project was sequenced in 2018, revealing actionable findings for 20 % of rare disease patients and 50 % of cancer patients. Diverse Data, Cancer 2.0, and Newborn Genomes are new offshoot initiatives.

2018
Saudi Arabia

Saudi Arabia
In a country where cosanguinous marriages have led to a higher frequency of genetic conditions, the Saudi Genome Project aims to build a genetic database of 100,000 sequences. The nearly 57,000 sequences completed so far have revealed 3,000 novel mutations connected to 1,230 genetic disorders.

The time is right

Wastewater surveillance arises as a primary tool for disease monitoring in the future

COVID-19 forced innovation and creativity in disease detection and surveillance. It was time for one of the most promising tools to emerge from the pandemic – wastewater-based epidemiology (WBE). While not entirely new, WBE has seen significant refinement during the pandemic thanks to improved molecular testing methods such as digital PCR, a highly precise approach to sensitive and reproducible nucleic acid detection, and quantification.

Analytical Chemist and Lab Manager, Clover Carlisle, has worked at the Environmental Lab of the Delaware Public Health Laboratory (DPHL) for over 15 years. Here, samples are tested from utilities throughout the state that provide drinking water to the public.

Recovering tiny fragments of SARS-CoV2 RNA from wastewater has emerged as a tool to detect a variety of diseases in a population before people spread a contagion to others.

Clover Carlisle keeps a vigilant eye on the cleanliness of Delaware's drinking water as an analytical chemist and laboratory manager at the Environmental Lab of the Delaware Public Health Laboratory (DPHL), located in Smyrna. After 15 years in neonatal testing at the lab, she's spent the past six years testing samples from utilities throughout the state that provide drinking water to the public. The EPA-certified lab keeps an eye on bacterial and chemical contaminants, organic compounds, metals and mercury, among other potentially dangerous elements.

When Delaware decided to expand its water monitoring to wastewater in the hunt for evidence of COVID-19 infections, the Environmental Lab took on the job. Wastewater-based epidemiology (WBE) is a method of monitoring disease circulation in a community in real time.

Recovering tiny fragments of SARS-CoV2 RNA from wastewater has emerged as a new tool in the fight against COVID-19 – and potentially beyond. Epidemiologists and public health officials are excited about its potential to detect a variety of diseases in a population before people show up at a doctor's office with symptoms or spread a contagion to others.

Main challenge: learning by doing

While COVID-19 WBE programs have popped up around the globe, DPHL is one of the first U.S. state public health labs to adopt the strategy. Wastewater is an emerging method. There aren't that many labs using it, and best practices are still in the process of being established. "There aren't a lot of other programs to reach out to for help," Carlisle says. "There just aren't a whole lot of people out there with experience."

The program at DPHL

When the COVID-19 pandemic began, DPHL took an all-hands-on-deck approach to processing the samples that were starting to flood in from all over the state by marshaling the skills – and quick trainability – of its staff. Taylor Moore, an analytical chemist at the environmental lab since 2018, switched from working as a primary analyst for disinfection byproducts to running COVID-19 assays in the Molecular Lab, where she got a crash course in PCR.

"That was completely new to me," Moore says. "It was a bit of a challenge at first, but it was very interesting. It helped me get familiar with the instruments, how to plate, master mixes, primers, probes. It set me up pretty well to move into wastewater."

Learning about dPCR

Carlisle's interest in wastewater surveillance was piqued by the American Public Health Laboratory (APHL)'s launch of a Wastewater Surveillance Community of Practice, a forum for APHL member labs to share resources about the emerging method of disease monitoring.

In the case of COVID-19, a person starts shedding viral RNA into their feces two to three days after infection. Once flushed, depending on site, it takes a couple of days to reach a wastewater treatment plant. Since COVID-19 symptoms develop 5 to 14 days after infection, if researchers immediately test for RNA fragments, they can learn of a person's infection before that person is aware they're ill.

"In these calls, it came up that QIAGEN was going to offer a pilot program in the future," Carlisle remembers. The pilot program was the testing of the QIAcuity digital PCR platform, a highly precise approach to sensitive and reproducible nucleic acid detection and quantification that can identify even trace amounts of fragmentary viral RNA in wastewater. Digital PCR can increase sensitivity five- to ten-fold.

"I spoke with the DPHL Director, Christina Pleasanton, and she thought this was a good opportunity for us to get involved. In the meantime, we were able to set up a qualitative assay looking at wastewater for the presence or absence of COVID-19. So we were analyzing samples using that in the beginning, before we were able to get to be a part of the pilot program."

Test pilots for QIAcuity

They partnered with the Delaware Department of Natural Resources and Environmental Control (DNREC), a state agency that has the authority to collect samples from wastewater treatment plants.

Of the18 publicly owned wastewater systems in the state, DPHL receives samples from 12 of them, twice a week.

DPHL then joined the QIAGEN pilot program in 2021. "The QIAGEN pilot program was an opportunity to be a part of a program that pretty much established a whole automated method, from extraction to plating the master mix to transferring to plates," Carlisle says. DPHL uses three QIAGEN instruments in this process. The QIAcube Connect does the extraction, the QIAgility plates the master mix, and the QIAcuity is the digital PCR. Its nanoplate digital PCR system partitions the sample into 26,000 individual reactions, increasing the chances of identifying a single positive.

Moore is one of the primary DPHL scientists operating the QIAcuity. "At first it was a little bit scary because nobody knew anything about it, and I was still kind of new to the molecular side of things," she admits. "So it was a bit of a challenge at first. But the instrument is very user friendly, and the software too. We were trained on it and able to pick it up pretty quickly."

Wastewater samples can be complex to work with. "As you can imagine, there are a lot of other things in wastewater samples besides SARS-CoV2, so a lot of the issues have to do with being able to work around that, with inhibitory factors," she says. "Some samples come with a bit more sludge than others."

Another challenge has been finding which concentration method works best for their purposes. "We can do PEG precipitation, which goes through a centrifugation process, but it's a bit more time consuming. It takes most of the day," Moore says. "It also requires a lot of centrifuges, which took up a lot of space. We recently just switched to a different concentration method that can concentrate a sample within approximately four minutes. So that time difference really helps now that we're getting a lot more samples than we were at the beginning." At first they were processing two samples a week, but that's grown to 26.

The advantages of dPCR

"The nice thing about the QIAcuity dPCR is that it gives you a quantitative result, so we're better able to see exactly what's going on within the sample," Moore says. "Now that we have it up and running, it's going pretty smoothly."

"Digital PCR is very interesting because you don't have to worry about analyzing standards to get a quantitative result," Carlisle says. "So that's what makes it such a great instrument to use. It's hard to find companies that are going to make these standards or controls to be able to report out quantitatively. Most clinical assays are only worried about finding out whether a pathogen is there or not."

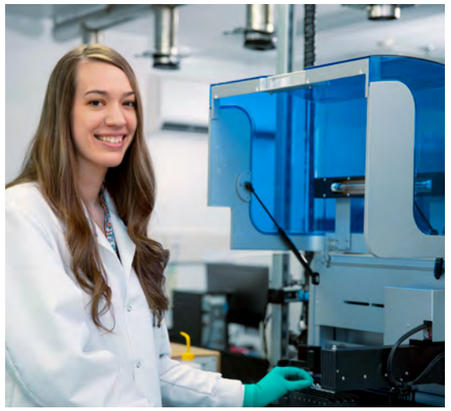
She adds, "With quantitative knowledge, you can report out how many copies/L you have of whatever you're looking for. That's going to show you when a trend is coming. You're going to see when there are a lot of patients that are shedding the virus but aren't actually showing any signs or symptoms. In theory, this is going to tell us about a week before a surge would hit."

Verifying results

"We're in the last part of our validation for the QIAGEN pilot program, and what we're trying to finish right now is kind of a performance test on the method where we look at a low volume, a mid volume and a high volume of copies per liter of COVID-19 virus," Carlisle says. "So once that's complete, we're hoping that we can start reporting out the digital PCR results. We're going to be uploading wastewater data into the National Wastewater Surveillance System that the CDC has created. NWSS has a dashboard that collects wastewater data from all participating states, allowing utilities and the general public to view current data specific to a location."

Working on WBE has been "a great experience," Carlisle says. Being one of the first state public health labs to incorporate WBE has had its challenges, but learning by doing has also been exhilarating. She believes DPHL is a leader in this realm – and her team is happy to share the knowledge they've gained. "I think we'll be one of the states that people will reach out to to help bring them into the wastewater-testing program," she notes. "We hope to see this being used in the future for many other infectious disease pathogens."

Taylor Moore is a primary analyst at the Environmental Lab with experience in disinfection byproducts and, more recently, running COVID-19 assays.

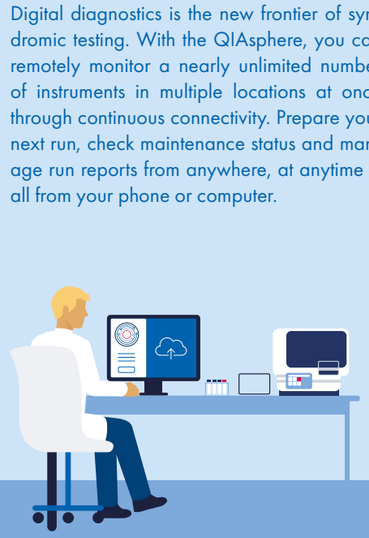


When the COVID-19 pandemic began, the DPHL team took an all-hands-on-deck approach to processing samples.

The digital PCR platform, QIAcuity, and its microbial DNA detection assays enable rapid profiling and identification of microbial species, antibiotic resistance genes and virulence genes from diverse samples. Areas may include wastewater samples, infectious diseases, human pathogens, the human microbiome, multiple drug resistance, sepsis, food production, or environmental samples.

Step out, do more

Digital diagnostics is the new frontier of syndromic testing. With the QIAsphere, you can remotely monitor a nearly unlimited number of instruments in multiple locations at once through continuous connectivity. Prepare your next run, check maintenance status and manage run reports from anywhere, at anytime – all from your phone or computer.



How does the QIAsphere work?

The QIAsphere connects your instrument to your phone or computer. All you need is a network connection. Installation is easy and straightforward, so your runs will be up and running in no time.

Why connect?

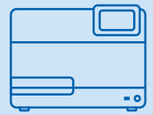
By automating mechanical tasks, you humanize the lab, allowing you and your colleagues to focus on what humans do best: dissecting problems, designing protocols and dreaming up possibilities.

Redefine productivity

An efficient lab doesn't necessarily require your presence if you can monitor its activities remotely. You've got more important things to do than wait for your runs to finish. Publish your results. Apply for a grant. Collaborate with a colleague.

QIAsphere seamlessly integrates with three QIAGEN instruments:

QIAcube Connect
provides fully automated spin-column extraction and purification at the push of a button.

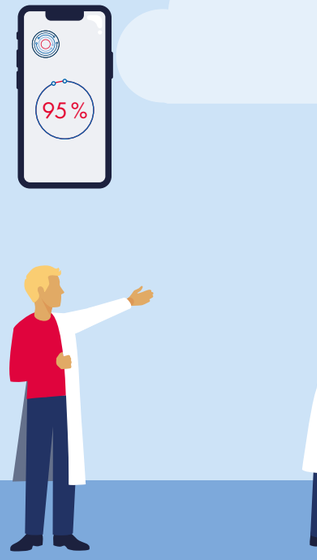


EZ2 Connect
Offers fully automated, end-to-end benchtop DNA and RNA purification for 24 samples at once.

QIAstat-Dx
Delivers multiplex syndromic testing results by detecting pathogen nucleic acids using real-time PCR

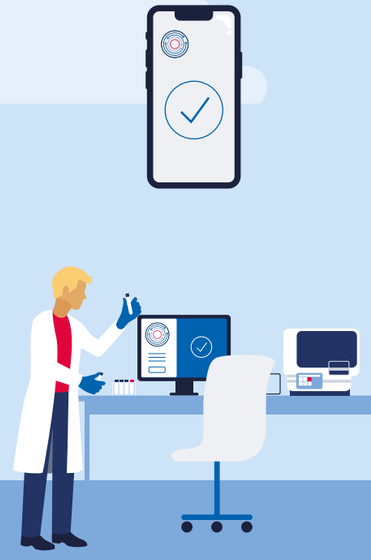
Maximize resources...

...without causing burnout. QIAsphere lets you extend productive lab hours without extending human hours. Take that lunch-break bike ride in the park.



Enhanced reproducibility

Fully automated processes reduce the chance of human error and increase consistent results. Rest assured, you have reliable data.



Upload and analyze

Connectivity between data and databases is essential too. You can plug your results into a bioinformatics ecosystem to maximize your insights.

The genetic impact

of radiation on our cells

Tim Mousseau, Ph.D. is one of the world's leading experts on radiation. His research interests have brought him to the Fukushima nuclear accident, to the Pacific's Marshall Islands, where the U.S. atomic tests of the 1940s and 1950s took place, and to volcanic islands known to have emitted radioactive gas. Now, after more than two decades in the field researching the animal guaranteed to thrive around human populations, canines, he's closer than ever to answering fundamental questions about radiation's effects on life on earth.

In 1999, Mousseau was a research scientist at the University of South Carolina (USC) and part of a team looking at the effects of radiation on the bird population at the nuclear accident site of Chernobyl in Ukraine. And the evidence was dire.

"It was a miserable experience," he remembers. "The weather was horrible. Everything was dreary and rundown. If you went into a building and used the elevator, the lights would dim as the power browned out."

The birds' bodies had developed tumors and abnormalities, such as albino feathers and asymmetrical wings, and they were dying earlier than they should have. In the most radioactive areas, many of the males were sterile. Examining the birds' sperm revealed "substantial damage to the morphology and the behavior of these sperm," says Mousseau.

"The major finding from our initial studies was that there was absolutely no doubt of genetic damage being caused by the radiation." The next question was whether only birds were being affected. "A few people suggested that maybe birds were particularly vulnerable," Mousseau recalls. "You know, the-canary-in-the-coal-mine kind of situation."

They broadened the research to include microbes, insects, plants and mammals, many of which repopulated what was known as the Exclusion Zone after people abandoned it. Every group showed dramatic population declines in areas of high contamination.

Looking for answers in canine DNA

That first visit sparked his decades-long pursuit of understanding the effects of radiation on natural systems. Today, Mousseau is a professor at the University of South Carolina and an internationally recognized authority on the subject.

When he's not living on a houseboat off the coast of Charleston, South Carolina, or spending weekdays in his lab at USC, Mousseau travels the world studying sites where radiation is known to be high, either from human or natural causes, to understand its effects on the genetics, heredity and health of a variety of living creatures.

Travelling the world in search of radiation

Mousseau's work has taken him all over the world in search of highly radioactive regions. Some are caused by human impact, and others are naturally occurring. He hopes to expand his studies to areas like Kerala in India, which are radioactive due to the natural breakdown of thorium and uranium. "The people and animals and plants have been living with this for hundreds of thousands of years, if not longer," says Mousseau. "We're hoping we might see some evidence of evolutionary response to the levels of radiation in these kinds of places."

And many are surprised to find out that his primary focus is our favorite animal companion: the dog. In 2017, Mousseau started his collaboration with the Clean Futures Fund, an NGO established to care for the dogs living in industrial accident sites.

They had contacted him to help with a project to spay and neuter the local dog population, which provided Mousseau with the opportunity to not only help keep the number of strays in check, but also to take samples for genetic analysis. Radiation's impact on living organisms can manifest in a variety of ways, but the core damage is cell injury. Mousseau wanted to see whether the dogs were showing evidence of genetic damage, and if they were passing that damage down to their pups.

But it wasn't only the dogs they were concerned about. The dogs had followed the people who'd begun to return to the region, including workers constructing a new containment facility around the damaged plant, and international tourists drawn by its dark history. "A lot of workers at the power plant were being exposed on a daily basis," Mousseau says. "They'd been told that this was actually not a dangerous area, and that the radiation levels were too low to be of concern."

"Dogs are a fantastic model for humans," Mousseau points out. "We basically have the same biology, and wherever there are people, there are dogs. So that association makes them an incredibly useful model for any kind of studies of human health."

Sampling 500 dogs in the wild

For the next three years, Mousseau and his team, which included students from South Carolina and Great Britain, collected samples from almost 500 dogs. They took blood samples and swabbed the dogs' mouths and rectums.

"My main objective was to quantify increases in mutation rates at the level of DNA in these organisms. How much genetic mutation occurs as a result of these exposures? No one had any idea," says Mousseau.

"One of the major innovations that really has allowed us to advance our research, especially with respect to genetic analysis, has been the ability to take samples and then to fix them and store them and preserve the DNA in the field without having to bring liquid nitrogen or blocks of dry ice with us, which in the first decade of our work was what we had to do."

They used QIAGEN's RNAlater and RNAprotect to preserve the biological materials without the need to freeze them. "This

The disintegration of atomic particles causes a release of energy that we call radiation. Radiation occurs naturally in sunlight, minerals, soil, rock, water, food, radon gas, and even our own bodies. It's also derived from human-made sources such as x-rays, nuclear detonations, power plants and some consumer products. Ionized radiation can be dangerous to living organisms by causing cells to become electrically charged (or ionized) as it passes through them. These jolts break or change chemical bonds, leading to cell impairment or death. While the terrible effects of high doses of radiation on living beings are well documented, many questions remain about its effects at lower levels – which is why work like Tim Mousseau's is so important.

Mousseau was first introduced to QIAGEN in the 1990s while studying the patterns of relatedness among trees and their ability to fight off pests.

"We're just at the very tip of the iceberg. We're finally bridging the various steps along the pathway that maps changes at the level of DNA to phenotype, and how the DNA is organized."

Tim Mousseau, Ph.D.
University of South Carolina

"Dogs are a fantastic model for humans. We basically have the same biology, and wherever there are people, there are dogs."

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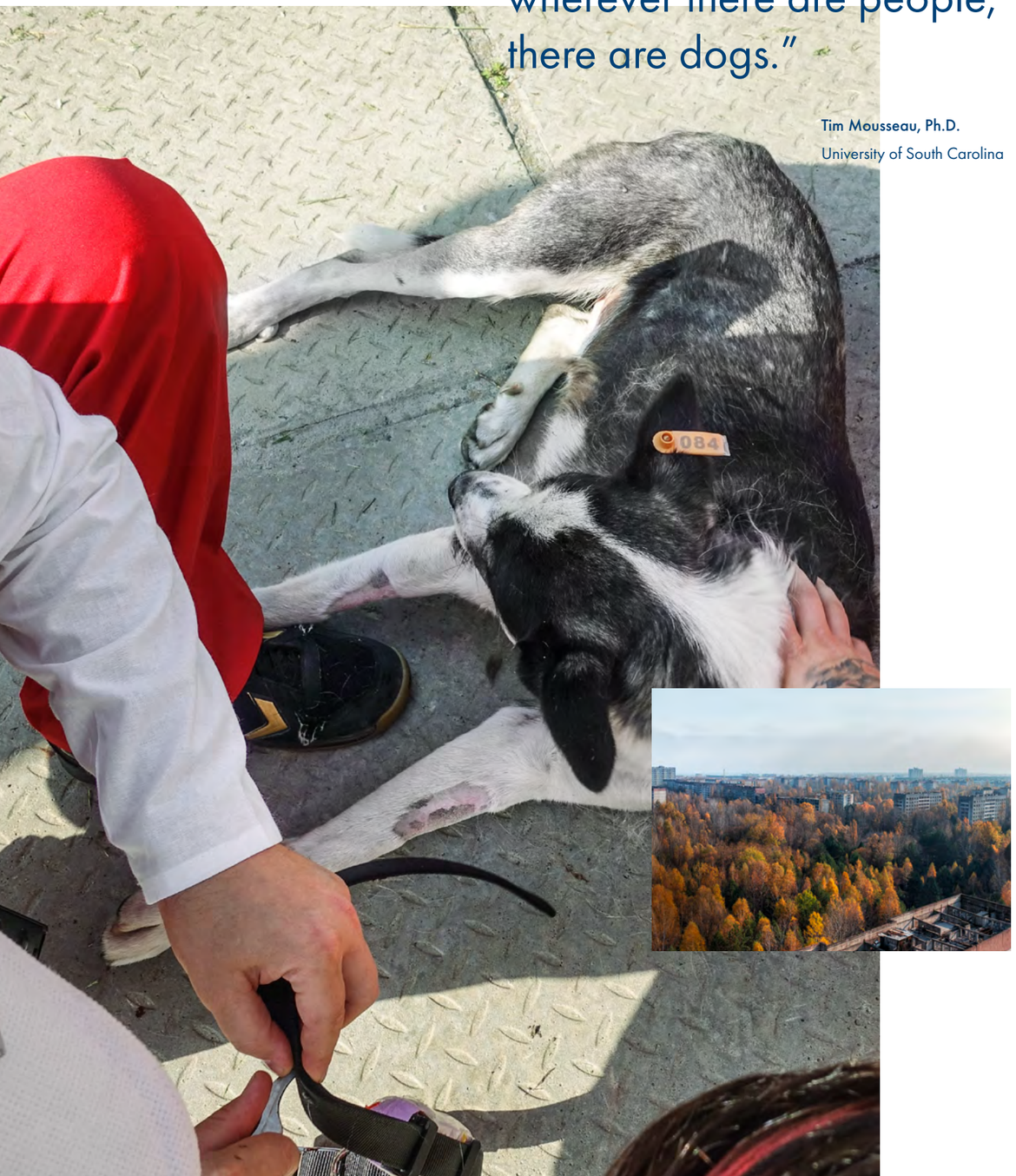

revolutionized our field work," he says. "A few years later, ALLProtect came along, which allowed us to also protect DNA and other biomolecules while doing field work."

The samples are now being sequenced at the National Institutes of Health, where he's partnered with a dog geneticist to analyze the samples for increased incidences of diseases, including cancers, and to see if genetic mutations are resulting from the high radiation levels.

"We're doing whole genome sequencing, and this will allow us to recreate the pedigree of these animals and determine whether or not they're actually the descendants of the pets left behind after the accident in 1986," he says.

Fundamental questions

The initial results are starting to come in. "We're certainly seeing some evidence of genetic changes in these populations." They don't yet know how many are leading to diseases "because we're still in the process of that part of the study. But it's certainly going to be fascinating, whatever we find, and will throw up some really exciting opportunities to address fundamental questions that no one has been able to address before."

They also hope to study the animals' microbiomes in conjunction with some Finnish colleagues who lacked the resources to do the work—until Mousseau stepped in. "I contacted my old friends at QIAGEN for ideas. After some discussion, the folks at QIAGEN decided to help out by extracting the DNA and running whole genome sequencing for the microbiome communities," he says.

In the Marshall Islands, his team has created an NGO called Visiting Veterinarians International that spays and neuters stray dogs while also taking samples for DNA analysis. "We're in the process now of extracting the DNA and sequencing to determine whether or not there are genetic changes that resulted from that exposure.

"Space is a very radioactive place"

Mousseau's research caught the attention of NASA after he was featured on a space-oriented National Geographic TV show. The agency contacted him "asking me if I'm the fellow that was doing studies of adaptation to radiation by plants in Chernobyl." He told them it wasn't the major thrust of his research, but that "we've made some interesting discoveries about how the pollen of plants in particular seems very vulnerable to the effects of radiation."

NASA then invited him to start working with them on the generation of plants and crops that can be grown in space for astronauts traveling to Mars. Both astronauts and plants will need to contend with cosmic radiation once they leave the protective bubble of the Earth's magnetosphere. Not only do the plants need to grow, "they need to be able to reproduce eventually. And so understanding how radiation affects plant growth under those conditions is going to be fundamentally important for manned space travel to places like Mars."

As for life back on Earth, Mousseau envisions one day perhaps taking his houseboat far from the coast of South Carolina. "I like fixing things," says Mousseau. "When COVID-19 hit, I decided that I needed to socially isolate, and what better way than to live on a boat? I bought myself an old fixer-upper and rebuilt the electronics and the mechanical parts. Maybe someday I'll use it for fishing and scuba diving, or maybe as a base camp for doing studies of dogs in the Caribbean and Central America."

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