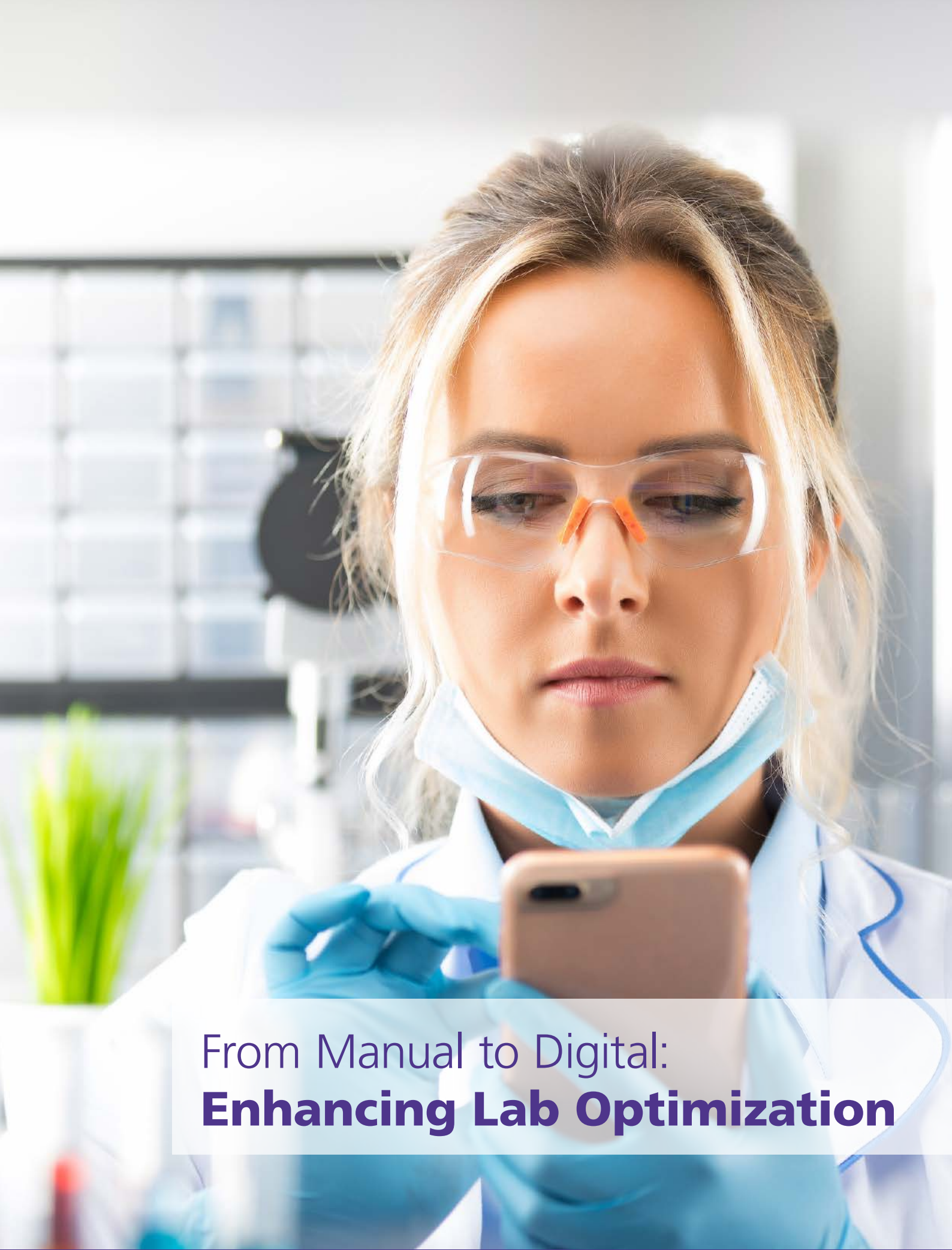

From Manual to Digital: **Enhancing Lab Optimization**

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Contents

Imprint
© Wiley-VCH GmbH
Boschstr. 12, 69469 Weinheim, Germany
Email: info@wiley-vch.de

Introduction

Laboratories, products, and people must adapt to the fast-paced world we live in today, to increase productivity and to do so in a more sustainable, cost-effective way. We have noted that scientists and lab employees can spend up to 25% of their time manually entering data into inventory records on such consumables as solvents and reagents. Inefficient inventory management can lead to wastage, inaccuracy, and non-compliance. In turn, this can affect the company's reputation and staff morale.

This eBook presents a solution to this problem by showing how to attain faster, error-free, and less-wasteful production across several laboratory sectors. In particular, this goal can be achieved via digitalization and digital transformation, which in the 21st century have become necessary steps in the optimization of businesses. By improving business agility, a company stays competitive, improves the customer experience, and produces better data analytics. Data analytics yield better insights into which processes can be improved, changed, or even discontinued. In addition, digital transformation of the laboratory can improve internal communication and collaboration with external partners and scientists.

The eBook summarizes the Wiley book Digital Transformation of the Lab, which discusses what the lab of the future looks like, considers people and cultures, takes process developments and optimization into consideration, discusses data management improvement, reviews lab environment and design, and, lastly, offers a practical guide for getting started. Included is an infographic on Merck's LANEXO® Laboratory Inventory, Safety, and Compliance Management System.

The Lab of the Future

The subject of digital transformation is actually about you. Your science, your everyday work environment, your partnerships and collaborations, and the impact of your work on the future of scientific progress. It is extremely challenging to organize data and keep everything traceable and reusable in the long term. The main criteria for lab digitalization and digital transformation is to answer one important question: Are we improving the quality, efficiency, and pace of innovation? Lab digitalization is a people-driven initiative that aims to address global challenges and provide solutions, backed by the unquestionable integrity of traceable and reproducible scientific data.

Inspiration

Steve Jobs once said, "The biggest innovations of the 21st century will be at the intersection of biology and technology." In this (r)evolution, the laboratory environment will most definitely play a key role.

When speculating on the future digital transformation of life sciences R&D, one must consider how the whole lab environment and the science that goes on in the lab will inevitably evolve and change[1,2]. It is unlikely that an R&D lab in 2030, and certainly one in 2040, will look and feel like a comparable lab from 2020.

People and cultural considerations

The lab of the future (LotF) and the people who work in it will undoubtedly operate in an R&D world with an even greater emphasis on global working and cross-organization collaboration. Modern science is also becoming more social[3], the most productive and successful researchers will be familiar with the substance and the methods of each other's work, which will break down more and more barriers to collaboration. These collaborative approaches will foster and encourage individuals' capacity to adopt new research methods as they become available; we saw this with the fast uptake of CRISPR technology[4]. "Open science"[5] will grow ever more important to driving scientific discovery. Enabling this will be the increased use of Distributed Ledger Technology (DLT)[6], a cryptographic method that will massively reduce the risk of IP compromise[7]. The LotF will also enable more open, productive, and collaborative work via vastly improved communication technology (5G moving to 6G)[8]. By working in such labs, people will benefit from much more open attitudes, cultures, and mindsets, given the influence of technology, such as smartphones in their personal lives.

Robotics and automation will be ubiquitous; however, with more automated assistance, the density of people in the lab will likely drop, allowing scientists to focus on key aspects and complex parts of experiments. Therefore, issues around safety and "lone working" – a term that refers to activities carried out in isolation from other workers, without close or direct supervision[9] – will grow. A focus on the interaction points that scientists have with automation will develop to ensure that they are working properly in safe environments. The few remaining lab technicians will thus fall into the category of *lone workers,* and ensuring their safety in the workplace would require consideration of new guidelines and upgrades. Moreover, not only will safe working grow in importance, but the need for organizations to deliver a better "user experience" (UX) in their labs will become key to helping them attract smaller numbers of more expert technicians and to retain them. The lab technician's UX will be massively boosted by many of the new technologies already starting to appear in the more forward-looking labs; e.g., voice recognition, augmented reality (AR), immersive lab experience, and a more intelligent lab environment.

Process developments and optimization

The lab processes, or "how" science gets done in the LotF, will be dominated by robotics and automation. But there will be another strong driver, which will force changes in lab processes and mindsets within the next 5–10 years: *sustainability.*

"Labs use 10 times as much energy as a typical commercial office space and use three to five

times as much water," says James Connelly, CEO of My Green Lab, a nonprofit focused on sustainable research[10]. "They also produce a significant amount of plastic and other hazardous waste." In the LotF, experiments will have to be designed to minimize excessive use of "noxious" (e.g., chemical and biological) materials throughout the experimental workflow and during cleanup afterward. Similarly, the use of "bad-for-the-planet" plastics (e.g., 96-, 384-, or 1536-well plates) should be reduced. New processes and techniques must be developed as alternatives to standard ways of working in the 2023 lab. To support the drive for sustainability, miniaturization of lab processes will grow hugely in importance, especially in research, diagnostic, and testing labs. The current so-called "lab on a chip" movement offers many examples of miniaturization processes[11]. Laboratories and plants that are focused on manufacturing will continue to work at scale, but the ongoing search for more environmentally conscious methods, including climate-friendly solvents and reagents, will continue, and the use of catalysts will grow ever more relevant as well[12]. There will also be a greater focus on better plant design. For example, 3D printing[13,14] could allow localization of manufacturing processes near the point of use.

An important consideration when thinking about the LotF is what we believe to be the fundamental difference between what we call hypothesis-driven labs and protocol-driven labs. The former labs are seen in pure research/discovery and academia. The experiments undertaken in these labs may be the first of their kind and will evolve along with the hypotheses that drive them. These labs will embrace high throughput and miniaturization. Protocol-driven labs, in contrast, include facilities, such as manufacturing, diagnostic, analytical, or gene testing labs. These tend to have lower throughput, though their levels of productivity are growing as automation and higher-quality processes enable higher throughput. Here, reproducibility combined with robust reliability is key. An example includes genomic screening and testing labs[15,16], which have been growing massively in the past few years. In these labs, the already high levels of automation will continue to grow.

In the hypothesis-driven lab[17], strongly driven by sustainability concerns and benefiting from the growth of ever-higher quality artificial intelligence (AI) and informatics algorithms, there will be more *in silico*, virtual "design-make-test-analyze" (vDMTA), and less tangible Make and Test **(Fig. 1).** Fewer "real" materials will actually

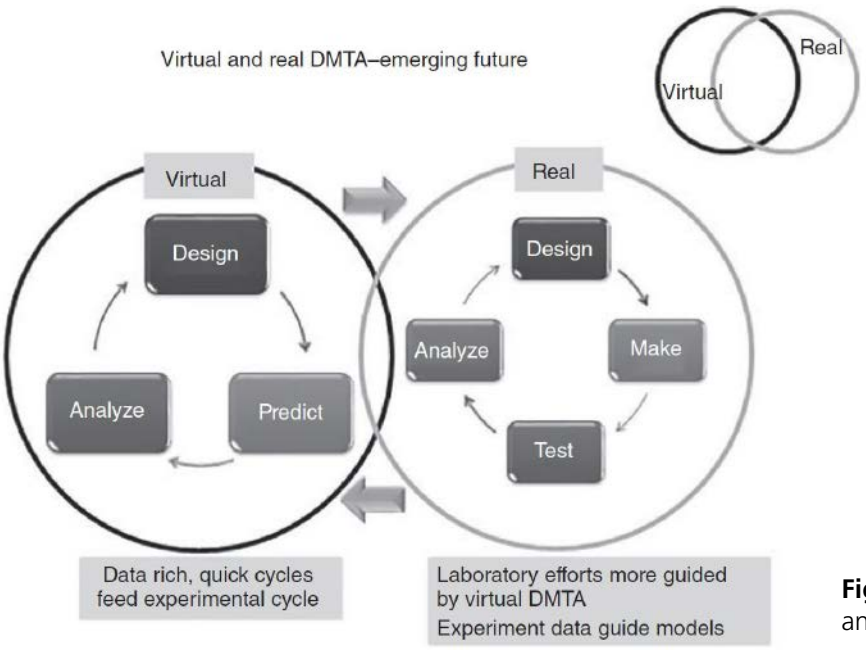

Figure 1. Virtual and real design-make-test-analyze (DMTA) concepts.

be made and tested, and those that are will be produced on a much smaller scale.

Finally, as labs become more sophisticated with higher levels of automation, robotics, miniaturization, and data production (but with less staff) – combined with the need for facilities to be both safe and sustainable – the concept of the "laboratory as a service" (LaaS) will grow[18]. The LotF will not be a static, self-contained facility devoted to a single scientific area: it will be a blank canvas, as it were, in a large warehouse-like facility or cargo container[19], which can be loaded on demand with the necessary equipment, automation, and robotics to carry out a contracted piece of lab work. That piece of work might be a chemical synthesis or a cell-based pharmacological assay one day, and an *ex vivo* safety screen in the same area the next day. Use of a modular design supported by fully connected devices will be key.

Data management improvements

It is true in 2023, just as it was 50 years ago and will be 50 years from now, that the primary output of R&D in whichever industry is data. Therefore, the recent emergence of the saying "Data is the new oil"[20] is unsurprising. While it may be viewed by many as hackneyed, and by many more as fundamentally flawed[21,22], the idea carries a lot of credence as we move toward a more data-driven global economy. One of the main flaws of the oil analogy is that, unlike oil with its very clear refining process and value chain, data cannot be easily and suitably refined into the next piece of the value chain. Furthermore, the sustainability credo of "Keep it in the ground"[23,24] makes the data/oil analogy perhaps even less useful. However, both within the LotF and in a more open and collaborative R&D world, experimental data (raw and refined) will grow criticality. Without a doubt, data will remain a primary asset arising from the LotF.

Lab environment and design

All labs will face pressure[25,26] to design sustainable spaces[27] that can keep up with all the emerging technology trends, as well as offer the usability and design features needed to support a new generation of scientists. The combination of these drivers will influence how the LotF evolves and how experiments are performed. Research institutions are already creating more "open" lab areas to support interdisciplinary teamwork, collaborative work, and joint problem solving, in contrast with the traditional "siloed" departmental culture. This will continue in the LotF. The growth of innovation clusters[28] and lab coworking spaces will require more consideration of how shared automation and lab equipment can be effectively and securely used by groups, who may be working for different organizations and who will want to ensure their data and methods are stored and protected in the correct locations. Effective scheduling will be critical in the LotF to enable high productivity and to ensure that the high value of the automation assets is realized. New technologies like quantum computing, AI, and machine learning (ML) will be relevant to LotF automation integration and interoperability.

From people and cultural perspectives, the point we would stress most is the importance of considering the LotF from the perspectives of the different professionals working in, around, or in association with it. Its scientists will include not just practical hands-on chemists, biologists, biochemists, physicists, etc. but also the new breed of data scientists and engineers: lab and building managers, technicians and equipment operators, and all the other staff who will make the LotF an exciting, stimulating, and challenging place to work. The LotF will be more open, collaborative, and automated if rather have fewer people. Critical to its success will be the "UX" of all its workers.

Processes in the LotF will be dominated by flexible automation and robotics, whether the lab is a hypothesis-driven research lab, protocol-driven manufacturing, or testing lab operating more in LaaS mode. More effective in silico modeling of these processes will make the LotF a safer, more productive place to work.

Not only will the lab environment be designed around intense levels of automation and robotics, flexibly configured, and interconnected,

it will more often than not be used remotely. Suitable data and network interconnectedness will therefore be absolutely critical to effective, secure LotF operation. The LotF will also be a markedly more sustainable and greener environment.

Finally, when considering new technologies such as AI/ML and quantum computing, and new methodologies such as CRISPR and CAR-T, we feel we cannot overstress that science, technology, research, and development never cease to evolve. Discoveries are being made constantly and will doubtlessly affect the LotF in ways we cannot predict in 2022. We can state quite confidently that the rise of technologies or scientific discoveries that cannot be envisioned in 2022 will significantly alter what happens in the labs of the future.

Practical Guide: How to Approach the Digital Transformation

Many of us who have spent at least part of our careers in research laboratories also think of them as places where we innovate. Innovations are mostly directed toward the specific research field; for example, finding a novel mechanism that will eventually be used as a new therapy to treat a specific disease. In academic research labs, such innovations are usually published as either research papers or patent applications. In industrial research labs, they become new products or services. Being 100% focused on your research, you rarely think of the lab as a place you can innovate itself, including the processes and tools used to generate research results. Consequently, lab workers often end up using very old and sometimes outdated approaches to planning, executing, documenting, and reporting their work. One might go so far as to conclude that, despite significant technological progress over the last several decades, the essential way we do science and research has not changed during this time.

Many labs are already using digital solutions to some extent: the majority of lab instruments now have digital data outputs that are stored, analyzed, and published. We read a lot of digital content such as online research publications, and we digitally prepare reports and research papers. However, many practices remain from the analog era, including extensive use of paper to plan, document work, and even manage results. The majority of laboratory data (including digital data) is not organized and is fragmented across multiple locations, which leads to temporary or permanent loss of data. Science is also facing data integrity challenges: organizations often are unable to assure the accuracy and consistency of their data. Being unable to find, access, and reuse data or assure data integrity causes serious bottlenecks throughout the entire research process, making it extremely inefficient. This is where digitalization can help. Digitalizing a research lab also improves data management and data quality, allowing data to become Findable, Accessible, Interoperable, and Reusable (FAIR)[29].

Some experts predict that digitization will be so disruptive or transformative that 4 out of the top 10 leading businesses across all industries will be displaced by digital transformation within the next 5 years[30]. This is also true for laboratories. Therefore, any effort toward digitalization of labs is not just beneficial but will soon become vital.

Labs looking to go digital

It is vital to know the differences between digitization, digitalization, and digital transformation. *Digitization* is a process that changes information from analog to digital form[31]. On the other hand, digitalization, as defined by Gartner, is the process of employing digital technologies and information

to transform business operations[32]. Finally, *digital transformation* is a process that aims to improve an organization by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies[33]. Digital transformation only happens when leadership recognizes the strategic importance of making profound organizational changes to the customer-driven company rather than technology driven.

We have compiled a list of very important questions that can help you identify your lab's needs and keep your decision-making process in focus.

1. Which challenges do I face now?
2. Which challenges need my immediate attention?
3. Which challenges do I see in the future?
4. How could the relevant changes affect my current business?
5. What is my long-term business strategy?
6. How do I manage legacy data?
7. How do I get people to cooperate?

Your answers will depend on many things, such as company or laboratory size, your position within the organization, your experience in change management, and your long-term strategy.

Evaluating the current state of your lab is necessary for defining the overall goals of the digitalized laboratory. For example, the goals of a digitalization project can be defined as follows:

Goal 1:
Improve data management by implementing digital tools (e.g., an electronic laboratory notebook [ELN]).

Digital tools such as ELNs or laboratory information management systems (LIMS) can significantly improve data management in your lab because they provide a framework for the implementation of good data management practices. The most significant benefit is data management efficiency because you can eliminate all paper from your workflow and automate calculations, report generation, and report overviews. In addition, many instruments routinely used in labs today can be directly integrated with LIMS, meaning that your lab staff does not need to worry any longer about transferring and saving data. In addition, digital tools offer better security and data integrity. You can measure improvement through improved efficiency and fewer procedural errors.

Goal 2:
Increase the efficiency of the laboratory by 25%.

Increasing performance starts by analyzing lab processes and the amount of time they take. Then, you can identify bottlenecks and look for ways to improve them. Some simple improvements might be digitalizing equipment booking, maintenance, and remote access to instruments. Many tools are already available for these ends and can significantly simplify daily operations in your lab. Then, you can measure performance by comparing the time spent on laboratory tasks before and after optimization.

In a survey on how professionals in highly regulated analytical and QC labs manage chemical inventory and comply with regulations[34], the vast majority of interviewees – 70% – indicated that their biggest problem was a lack of real-time information and automatic updates on the statuses and location of required chemicals. This led to decreased productivity and increased waste. One digital tool that can help labs overcome these issues is the LANEXO® Lab Inventory, Safety and Compliance Management System from Merck, which is specifically designed to create efficiencies, improve safety, and facilitate compliance within highly regulated analytical and QC laboratories.

Through simple digital data capture of RFID tags placed on consumables, the easy-to-use LANEXO® Mobile App lets users rapidly, effortlessly, and accurately register and archive reagent data, whether they're restocking shelves or recording experimental workflows. The availability of real-time consumables data affects functions across the organization; improves lab

productivity and sustainability; and supports traceability, regulatory compliance, and audit readiness. The system reduces the time spent on inventory management by tracking stock levels and monitoring expiration dates. Moreover, the LANEXO® Inventory Manager cuts compliance and safety risks by automating the traceability of reagent documentation and storage compliance checks and reduces errors with easy specification and identity checks along experimental workflows. In terms of sustainability, digital tools like the LANEXO® Inventory Manager enable more effective inventory management and minimize chemical waste by providing an accurate, real-time representation of current reagent stocks.

Goal 3:
Improve data integrity and efficiency by eliminating manual steps from data flows.

This goal extends Goal 1 by integrating lab equipment with the digital tool you are introducing. This helps you to eliminate manual data management. You can measure your success by tracking efficiency improvement (see Goal 2) and error rate (see Goal 1).

Goal 4:
The acquisition of new technologies should be 100% embraced, and it should be easy for users to start using the new tools.

One common problem with digitalization projects is user adoption. That is why we want this to be an important and equal part of our digitalization strategy and we include it as a requirement. Most often, digitalization projects fail because they do not implement a digital culture within the organization. In other words, implementing technology is easy, but if people do not use it, it is a failed investment. User acquisition should be carefully planned and regularly tracked. One good approach is to survey users on their experience with the new technologies and solicit suggestions for improvements.

Goal 5:
Projects should be finished in 12 months.

The digitalization project will affect your whole organization. Therefore, it is important to stick to the planned timelines. You should be clear and transparent about how much disruption will occur across the organization and what will happen after the project is finished. Make sure to treat this project like any other project within the organization, with a project manager and a dedicated project team. Do not forget to follow its progress and address any problems immediately.

After you have set your goals, it is time to describe the processes happening in your lab, which are the most common obstacles to improving lab efficiency laboratory. We often see that minor administrative processes such as scheduling, equipment booking, report generation, and logging require several resources, are repetitive, or simply hinder the efficiency of the laboratory. That is why you will often find improvement opportunities in such simple tasks.

Many experiments inherently consist of a good portion of the workday. A surprising amount of additional time is spent tracking down the necessary reagents, transferring experimental data from the instruments to your workstation computer, and perhaps even converting that data to other formats to facilitate analysis. This can add hours of tedious labor to an already demanding set of tasks. However, digital solutions that can help your lab personnel stay squarely focused on their research are becoming more common. The loss of productivity due to unnecessary expenditure of energy and effort is known generally as “motion waste,” a concept created by the Japanese engineer Taiichi Ohno in the mid-20th century.

As previously mentioned, inventory management is one example of motion waste. Even cutting-edge research labs continue to rely on outdated manual solutions for tracking their reagent stocks. “We used to perform all inventory counts by manually writing down what is in the

cabinets and rewriting it in Excel," says Sarah Waldenmaier, a quality control technician at Merck[35]. This laborious process can be done only so many times in the space of a week and creates ample opportunities for recording errors. As a result, researchers may find themselves going on a wild-goose chase, hunting throughout the lab for chemicals that don't exist.

Laboratories of any size have multiple processes already in place; therefore, it makes perfect sense to use these existing resources. These are usually documented in standard operating procedures (SOPs) or similar documents that you already have in the organization and which contain all the information you need.

In the event that your lab processes are not described as such, or their descriptions are inadequate, you need to spend some time describing them. This is essentially similar to writing SOPs. The most basic form of an SOP contains the steps of the process, with some metadata, such as number, title, and author. You might want to separately describe the needed materials and tools. Then write down the steps, which can be sequential or hierarchical. Simple processes usually follow sequences of steps, while complex ones might cover multiple different scenarios. You can also use diagramming software such as DIA or draw.io to create this documentation.

At this stage, you should have all information collected and processes described. Next, you can analyze the collected information on the current state of data flows and processes, identify opportunities for digitalization, shape them into one or more projects, and define digitalization goals for each one. This is probably the most difficult stage, requiring experience with digitalization and optimization of processes and data flows.

The main bottlenecks in data flows are manual tasks, which affect both the efficiency and the data integrity of the lab. By automating these tasks via device integration and data automation, you can increase your lab's efficiency. This normally also makes users happier, since they spend less time on tedious tasks. Regardless, you should consider their opinions when introducing such changes.

While bottlenecks in data flows are a good starting point for process optimization, the main opportunities to improve lab efficiency are more likely to be found in other bottlenecks. This is why we must consider bottlenecks in processes that take a lot of time and are repeated often.

We will use the process description we prepared earlier, which is usually based on SOPs in your lab. Finding bottlenecks in processes takes much more time and dedication, mostly due to a large number of processes in the laboratory. Focusing on processes with long durations or that are frequently repeated over a day yields the greatest improvements in efficiency. You can use the information obtained after this analysis to prioritize the processes that need immediate attention rather than those where optimization would have less effect. In the following sections, we discuss some guidelines and good practices you can use as starting points. But you might find other approaches and targets more relevant to your organization.

Once you have identified your bottlenecks, you can perform a gap analysis based on the previously obtained information and analyses. In this procedure, you identify the differences between your current state and the state you hope to achieve by the end of the project. The gap analysis results will inform the digitalization strategy planning phase of your project. It is important to properly document this analysis. For example, divide a large sheet of paper into four columns: Current State, Future State, Gap Description, and Solution.

The *Current State* column lists the processes, workflows, and characteristics that need improvement. The focus can be on the entire laboratory or a specific task. Moreover, the analysis can be quantitative or qualitative. The *Future State* column outlines the target condition you want to achieve in the lab. As in the Current State column, it can be described in qualitative or quantitative terms. The next column, *Gap*

Description, should identify the gap between the lab's current and future states, outline its nature, and highlight the root causes that contribute to it. Again, its components can be quantifiable or qualitative. The final column of the gap analysis, *Solution,* should list all possible solutions you can implement to close the gap between the current and future states. These must be clearly described and should include deadlines.

When your gap analysis has produced solutions, it is time to implement them. This can be just as challenging as performing the gap analysis itself since resistance from users to the digitalization process is quite common. Some common user objections can be predicted and managed. "I do not want to change because":

1. The current system works well for me.
2. The current system works well because I helped to establish it. There is no need for a new one.
3. I do not have time to change; my schedule is already full.
4. The new system looks complicated and will take a lot of time for me to learn it.
5. I do not trust people who are making the change; they do not understand how we work.
6. How will I benefit from the new system? I really do not see the added value for me.

Equally important is establishing a steering committee to take charge of carrying out the digitalization projects or strategy. The project team should represent all stakeholders within the company, including end users. Everyone should have a voice. Make sure to identify key stakeholders. Within the various labs in your organization, these could be individual departments, functions, or positions, e.g., lab technicians, researchers, R&D managers, and QA managers **(Fig. 2).**

Once you have assembled the steering committee, the team can identify high-priority projects (within the digitalization strategy) as well as define project plans or charters, milestones, and timelines.

It is crucial that everyone understands why changes are being planned, which projects are being prioritized, and how they will be executed.

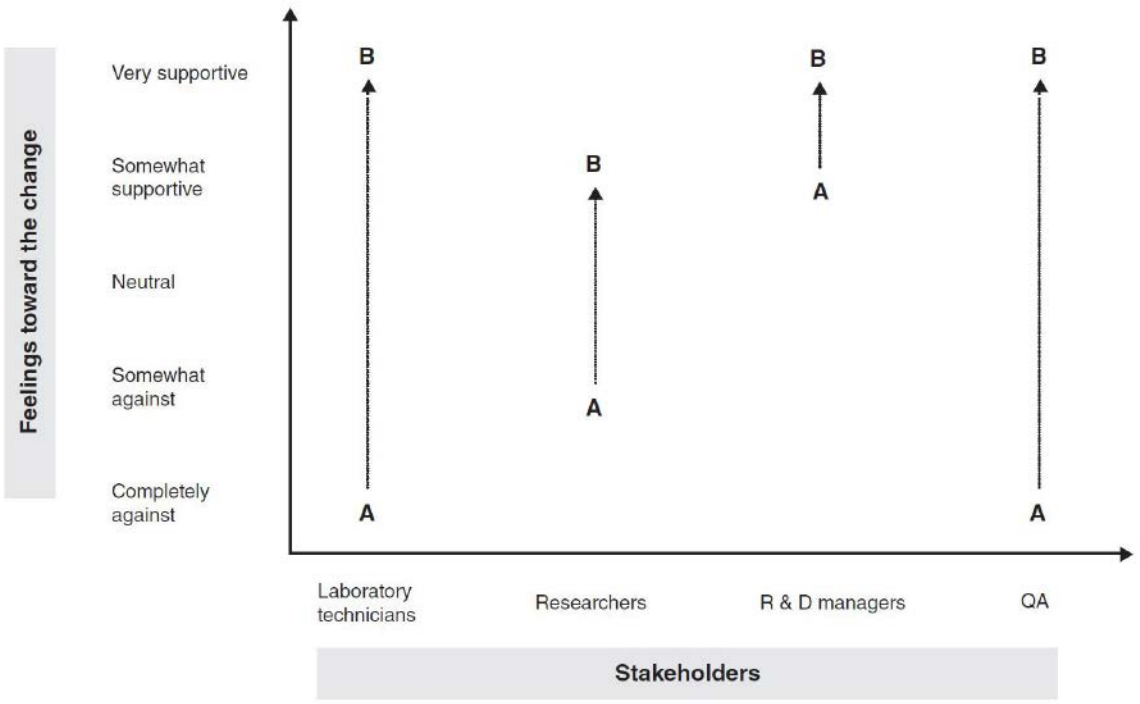

Figure 2. An example of a graphical representation of stakeholder analysis. Draw arrows and write a strategy for how to move from A (current state) to B (desired state)[36].

At this point, make sure you are ready to answer any questions and address all concerns that you will hear in response.

Stay in contact with the employees throughout the project, acknowledge their ideas, and communicate your progress. You might be surprised by how many great ideas you will receive. Moreover, provide a feedback mechanism since getting feedback is necessary at any stage of the project. In this sense, user happiness, engagement, and adoption are key indicators to measure when implementing new technologies or tools in the lab.

Conclusion

Digital transformation uses technology and software to transform the way laboratories operate. You can expect some level of resistance since rethinking and redefining the way of working in a laboratory or another organization that has been operating for many years is not an easy task. Humans are creatures of habit, and people in an organization get comfortable with the way processes are set up, with predictable revenue streams and very fast planning. They also wonder whether now is a good time to make changes, especially if things are stable. Even though understandable, this mindset will leave your laboratory in the status quo. Careful planning is key to improving your lab's operations. Moreover, proper communication of every change to all employees and leadership is extremely valuable. The commitment to these concepts – planning and communication – make the difference between a successful and an unsuccessful digital transformation.

The first step to digitalizing your lab is accepting that transforming a paper-based lab into a digital one is not a quick, simple process and that it will take time. Furthermore, this is not solely a technological solution. It is as much about the people in the lab and the practices of your organization as it is about the technology.

It is also imperative to realize that different laboratories will require different digitalization strategies. A crystallography lab cannot be digitalized in the same way as an organic chemistry lab. Even if the perfect solution were identified for one laboratory, it almost certainly would not align with another, because the latter lab will use different processes, contain different equipment, and have different needs. Scientists organize and conduct their work in very personal ways, as demonstrated by Kanza *et al.*[34,37,38]. Industrial labs often have standardized practices, although these can differ among companies. Academia, however, is a very different kettle of fish, as it is typically a much freer environment. Universities have many different types of chemistry labs housing different types of equipment and dedicated to different subdomains of chemistry. Potentially the most important in this context is that these labs are supervised by different professors or other academics.

Take the time to map out your current laboratory workflow, understand which processes are paper-based, which (if any) are electronic, and most importantly understand the data flow and how information is passed around the lab.

To run your lab efficiently and increase its productivity, it is also crucial to implement lab inventory management systems. Inventory management, which is typically separate from experiments, allows tracking of samples, reagents, and equipment. It consists of keeping track of reagents in stock and their locations, expiry dates, and storage conditions; the reordering process; material safety data sheets (MSDS); and waste protocols. Effective inventory management minimizes waste and is significant in reducing substantial costs and saving time. It also has a significant human impact as it prevents every scientist from having to perform the same tasks multiple times, allowing them to focus on the core research. Additionally, automated cloud systems enhance collaborative actions and improve interdepartmental relationships, providing a tool for real-time communication across a centralized interface.

Finally, a key aspect of attaining the LotF is turning paper habits into digital proficiency. As paper notebooks continue to accumulate data and as our labs grow in size, we may be faced with the dilemma of searching through paper notebooks to try to find particular datasets or

switching to an ELN where searching would take less than half the time. The widely promoted best practice in research data management is to embrace robust file-naming conventions, well-organized directory structures, and compliance with FAIR principles (that all data should be findable, accessible, interoperable, and reusable).

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The Challenge for C-Suite Leaders:

Unproductive Time and Everyday Inefficiencies

Adapted from:

1. Chemical Waste: The True Cost of Inefficient Inventory Management
2. Time is Money: The Hidden Cost of Inefficient Laboratory Practices
3. Prioritizing Innovation to get Ahead of the Market

Overview: Everyday Inefficiencies in the Lab

Scientists are highly trained professionals, but they spend up to 25% of their time manually entering data into inventories.

Inefficient inventory management can lead to wastage, inaccuracy, and non-compliance. In turn, this can affect company reputation and staff morale.

Manual recordkeeping is mundane and repetitive. It is easy to make errors, and errors can have serious consequences.

The EU Commission says research data should be FAIR:

- **F** Findable
- **A** Accessible
- **I** Interoperable
- **R** Reusable

Inventory records

Entries for reagents must state several things, including but not limited to:

- Arrival details
- Opening dates
- Expiry dates
- Handling of reagent before use
- Handling of reagent after use

The impact of data errors

Manual data entry → Data inaccuracies → Root cause analysis → Correction or repetition of experiments → Waste and delay

Spoilage waste

Commonly used reagents are often handled by different laboratory staff, making them harder to keep track of and therefore to monitor inventory.

Multiple bottles may be open at once, resulting in resource mismanagement and wastage.

60% of scientists say they use an inventory management tool, but 90% still struggle to find consumables.

52% of researchers have discarded unused or expired stock.

17% lose 10% or more of their inventory each month to spoilage and expiry.

Spoilage costs may include:

- The cost of the reagent that is discarded
- Shipping, maintenance, and disposal costs
- Wasted costs of experiments using expired reagents
- Reputational damage from inaccurate data and delays

Risk of Non-Compliance

Without a good inventory management system, laboratory audits are time-consuming and risky.

Failure to provide consumable traceability to a regulatory authority can result in a warning or fine of up to 30% of a company's annual revenue.

Poor inventory management can also result in mixed storage of hazardous substances, posing a risk to workers.

To maintain compliance, companies must:

- Maintain digital records for complete traceability
- Use consumable-centric, time-stamped audit trails
- Implement systems to monitor storage conditions and alert/notify lab staff of changes in real-time

Have you bought into a poor solution?

A solution can improve inventory management only if it works in practice as well as in theory.

If an inventory management solution is not user-friendly, it will be used incorrectly (or not at all by some digital immigrants) or take up additional valuable time.

Budget plans aim to reduce costs and manage resources. Is inefficient data management a blind spot in your system?

Would your scientists flag inefficiency, or would they become demotivated and look for another role?

Improper data management costs the EU economy €10.2 bn each year

Highly trained scientists waste time searching through cabinets for reagents. The cumulative effect of lost productivity could cost a company its competitive advantage.

It can take a researcher up to 50 minutes to find a sample in storage.

What does a good inventory management system look like?

Look out for these features in an inventory management system:

Easy to capture data – a good system can reduce input time by 97%.

A centralized inventory board where records can be viewed easily and in real-time.

Easy to use, easy to adopt by digital immigrants, and effortless to integrate into workflows without extensive training or IT setup.

Key outcomes of using an efficient digital inventory management system:

- Maintain compliance
- Retain scientific talent
- Expedite research timelines
- Attract funding

The Solution:

Prioritizing Innovation to Get Ahead of the Market

How to Overcome Routine Administration Tasks: Better Inventory Practices

Development of new therapies is a key driver of growth for the pharmaceutical industry, but time that could be spent discovering new drugs is being wasted on inefficient administrative processes.

The number of new drugs approved by the US Food and Drug Administration rose by 60% between 2010 and 2019.[1]

Ten times more money is invested in drug R&D in the US now than in the 1980s.[1]

Over half of scientists say they lose at least 3 days per month to inventory analysis.[2]

Half of scientists say they are expected to check inventory at least once a week, which costs a day's worth of innovation.

Companies that focus on innovation in a crisis outperform the market by 30% and recover from the crisis faster.[2]

Improving Regulatory, Safety, and Sustainability Compliance

The groundwork for a successful submission for regulatory approval starts in the laboratory, with robust data that stands up to scrutiny.

FAIR data standards ensure a robust approach to data:

- Collection
- Annotation
- Archival
- Reliability

A digital laboratory informatics system:

- Yields consistent, accurate inventories
- Removes manual data errors
- Ensures data integrity and data traceability

An integrated, single-source-of-truth system reduces safety risks and assists with audit trails, helping labs ensure compliance.

What is the LANEXO® Inventory Manager?

The latest from Merck's portfolio of digital laboratory productivity initiatives, the LANEXO® Inventory Manager is a laboratory inventory, safety, and compliance management system.

As a cloud-based, off-the-shelf solution, the LANEXO® Inventory Manager can be accessed through mobile and web-based applications, is easy to implement and set up, and has limited training requirements.

The LANEXO® Inventory Manager simplifies and automates inventory management through a combination of software, data management tools, and radiofrequency (RFID) labels.

The digital mobile application lets scientists easily discover reagent status, including:

Location

Which item should be used first

When to reorder consumables

As a single source of truth, the LANEXO® Inventory Manager frees scientists from the laborious administration associated with disconnected files and manual logs.

Automation and digitalization free up scientists to spend more time on R&D activities that result in growth and innovation.

Real-time consumable data contributes to:

- Reduced administration time (and consequently improved productivity)
- Reduced spoilage and sustainability
- Better traceability
- Audit readiness (contributing to regulatory compliance)
- Real-time alerts on storage incompatibilities
- Instant access to instructions on how to safely handle consumables
- Access to SDS

What does a laboratory inventory mean to you?

- A retrospective auditing technique
- A tool for productivity and efficiency control in real time

70% of scientists feel their biggest problem is a lack of real-time information and automatic updates on the status and location of chemicals.

ROI calculator

Estimate how much time you lose during routine inventory management tasks.

The LANEXO® Inventory Manager can be introduced swiftly, helping you to make a return on investment from day one.

Since its launch in March 2020, the LANEXO® Inventory Manager has delivered encouraging results.

One large pharmaceutical client reported:

- 97% reduction in chemical inventory management time
- 92% reduction in time needed to check, find, and document consumables
- 1.7% increase in R&D expenses
- Spoilage rate cut from 10% to 2%

A smaller laboratory client employing 10 scientists also reported benefits: their spoilage rate dropped from 20% to 5% after they implemented the LANEXO® Inventory Manager.

1. Congressional Budget Office, April 2021: https://www.cbo.gov/publication/57126
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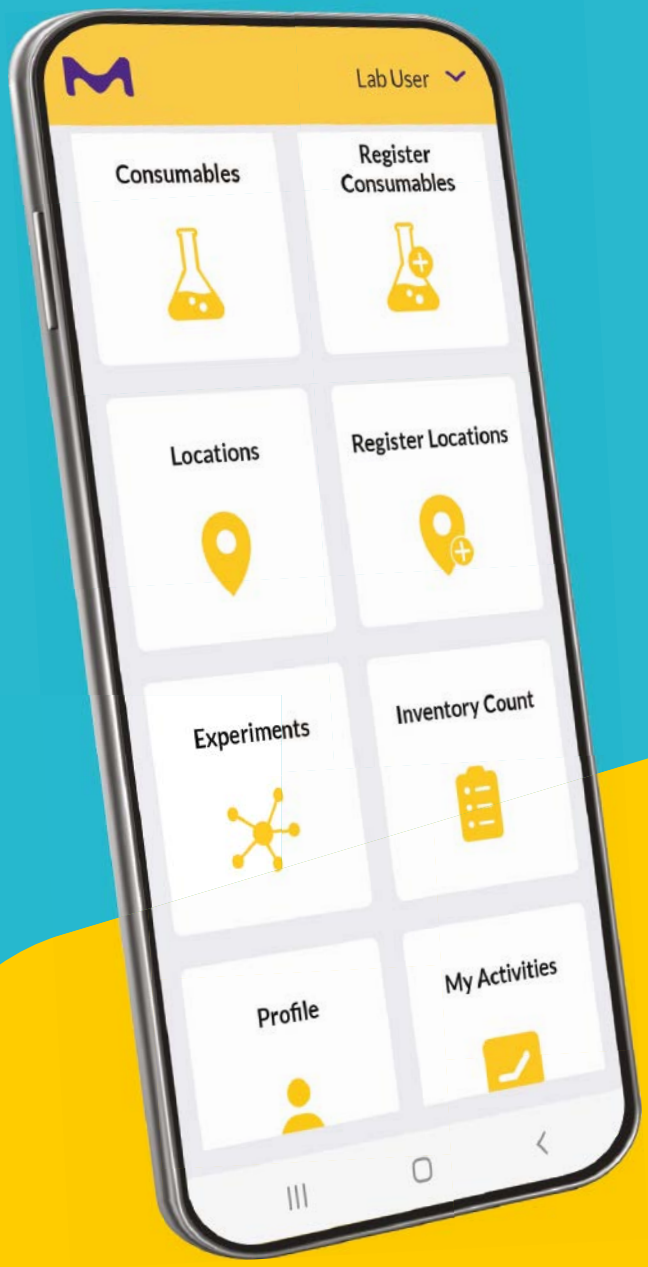
LANEXO® Inventory Manager for Regulated Labs

The LANEXO® lab inventory manager lets you automatically track the chemicals you have in stock, see where they're stored, and tell at a glance if they've been opened or if they've expired.

Comprised of a mobile app and RFID labels, the LANEXO® mobile app captures data from lab consumables with just a few taps on your device and stores the information in a secure cloud. You can access detailed, real-time inventory data – including SDS, owner, opening and expiry dates, location, usage and disposal information – anytime, anywhere.

This way, LANEXO® application not only simplifies your stock management across multiple sites, but it also ensures full regulatory compliance, such as with FDA regulation 21 CFR Part 11. It's time to say goodbye to Excel, pen and paper. Discover the fast track to an audit-ready lab.



Request Demo here:
lanexosystem.com

The Life Science business of Merck operates as MilliporeSigma in the U.S. and Canada.

MK_AD11876EN 46212 01/2023