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2024 INDUSTRY TRENDS:

LABORATORY

The life science industry is currently in “[Industry 4.0](#),” meaning the use of advancements such as automation, artificial intelligence (AI), machine learning (ML), and data analytics, is expansive and growing. The reason for this categorization is the significant impact these innovative tools can make, especially within [life sciences labs](#).

Many labs have increasingly started to utilize more [technology](#), and for those that haven't, they likely plan to in the next one to two years. The opportunities labs have to take advantage of these up-and-coming tools are vast. Automation, AI/ML, and data analytics can reduce simple, repetitive, and time-consuming tasks so labs can focus on high-quality, groundbreaking results. While there are many benefits to leveraging technological advancements within labs, concerns over data privacy, ethical principles, and federal regulations must be considered.

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LEVERAGING AUTOMATION FOR LAB OPERATIONS

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1 LEVERAGING AUTOMATION FOR LAB OPERATIONS

Almost every company values efficiency and effectiveness in their operations, and there are many tools that can assist in creating this reality. [Automation](#) has evolved to become a key asset for many labs. A main benefit is automation doesn't require constant human supervision. Labs that have leveraged automation don't have to worry as much about staffing issues and labor costs when they have machines to do tasks for them.

Automation can perform [simple tasks](#) such as pre- and post-analytic steps like barcoding, re/de-capping, sorting, etc. This reduces human error and significantly increases productivity. Automation allows lab technicians to focus on more complex work, resulting in faster turnaround times. Automation will continue to be added to and evolve in labs to make the most positive use of its capabilities. These capabilities "precisely and accurately conduct [routine tasks](#)... which is especially helpful for high-throughput screening and next-generation sequencing experiments." It's predicted the global [market](#) for Modular Laboratory Automation will reach a revised size of US\$5.7 Billion by 2030.

If labs are cautious about using automation, they can start slow by using [partial automation](#), which is automating one repetitive step. Labs can make this more beneficial through modular lab automation where equipment connects to automated tracks and robots. Similarly, automating a simple workflow can be more complex but has extra benefits. Providing the most benefits to labs is total automation, which refers to entire processes utilizing multiple automated tracks, robotics, and instruments to get them to all work together.

Mobility is another benefit gained through automation. It can allow for remote devices to be used to track equipment. For example, [remotely monitoring](#) equipment within labs helps with conducting tests and experiments. [Electronic lab notebooks \(ELNs\)](#) are another way automation and mobility are transforming labs. [ELNs](#) allow for easy access, edits, and comparisons to previous data and experiments. Lab equipment can be automated to take direct outputs and add them to the ELN. All this assists with consistent documentation and the ability to easily collaborate with others.

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2 ADVANCEMENTS IN ARTIFICIAL INTELLIGENCE (AI)

Currently, AI is trending for all industries, and it's a race to see how it will be enhanced and used next. From a [study](#) that included 200 lab professionals and R&D experts in top pharma companies, the industry expects “that wearables, virtual reality, and augmented reality technologies will be a key feature of the lab of the future,” with 40% of respondents indicating they'd use such equipment in the next two years.

The life sciences [market size](#) for AI investments is predicted to be around \$8.92 billion before 2032. In labs, AI is helping advance healthcare by allowing patients to use [remote devices](#) to assist with screening, diagnostic tools, and more. This allows for patient care to drastically improve because healthcare providers or labs doing experiments have real-time, accurate data upon which to base decisions.

Machine learning (ML) is a branch of AI which can “identify [patterns](#) in medical records, images, and genetic data and even make automated decisions based on these patterns.” ML, also growing within labs, applies algorithms and statistical models to a large amount of data, helping to reveal patterns so humans can make informed predictions and recognize trends. This saves lab technicians massive amounts of time. Labs can utilize ML through analyzing therapies, medicines, drug developments, and more. Lab technicians can hone in on specific aspects of their work and use AI and ML to assist, progress, and improve. It's believed AI will help to realize many more [operational enhancements](#) in the near future. In fact, one [survey](#) revealed that AI and ML will be the top tech investment over the next two years (60% of respondents), and more than half of the respondents (54%) say their labs are already using AI/ML.

While ML is popular in many labs, some [biotech](#) labs are hesitant to implement this technology. The main reason for this is data models are much more complex and not as widely agreed upon as in other industries. The data models in biology vary, making every aspect of collecting and generalizing data much harder for biotech labs to use ML. A time-consuming but effective solution to this problem is re-organizing and standardizing old data to start having data systems be cleaner and flow better.

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UTILIZING DATA ANALYTICS EFFECTIVELY

Data analytics in labs can provide substantial insight if used correctly. In 2023, a [study](#) was completed surveying employees working in various positions within different labs. Almost half of the respondents stated they're "utilizing data analytics for some aspects of their operations and planning more," and 23% indicated they'd like to begin doing so. Data analytics is a great place to begin when advancing labs because it's less involved than other technological tools due to existing data that can transformed and acted on.

Taking advantage of data analytics can streamline business operations and allow informed decisions to be made faster. This is important because labs will quickly fall behind competitors who are using data analytics. Labs can leverage the data they already have, whether it's from clinical studies, manufacturing, or R&D.

In addition, it's essential for labs to be consistently and regularly managing, migrating, and modeling their [data](#) to get the best use and value from it. There are also [tools to help labs keep track of their data](#) to ensure it's cross-functional – meaning when the data is used, it's clean and validated. Taking data from over several years and applying data analytics can optimize and diagnose treatments, providing big improvements for labs. Additionally, labs already using AI/ML and automation can expand their use to perform data analytics. Data analysts can leverage these tools to create predictive analytics, find new opportunities, mitigate problems, and automate decisions.





4 NAVIGATING TECHNOLOGY REGULATIONS

In 2024, we can expect to see stricter regulations and governance frameworks surrounding automation, data, and [AI usage](#), ensuring that its implementation is ethical and fair. Companies will have to prioritize [transparency and accountability](#) to build trust with both employees and consumers.

Presently, there are no explicit legal regulations in place for any automation or AI/ML. Data privacy has some regulations but nothing extensive enough to cover data analytics in labs. Ethical principles that have been in place regarding healthcare are expected to be followed even with new innovative tools. Mobility, including remote devices to monitor and track patients' health, is a concern for some labs as it regards data privacy. The healthcare industry and big data are now discussing the management of electronic medical records ([EMRs](#)).

Additionally, [in 2023](#), the U.S. Department of Health and Human Services said it's considering updating regulations on electronic health records, and the U.S. government is investing \$19 billion to accelerate the use of electronic medical records. This would also include ELNs. A lot of this data is considered protected health information ([PHI](#)), which is sensitive data. The use of the above is making it harder for labs to not only comply with the original, complex regulations in place – Health Insurance Portability and Accountability Act (HIPAA) and the Health Information Technology for Economic and Clinical Health Act (HITECH) – but also ensuring the same regulations are followed on any new data labs are bringing in. When implementing mobile devices or ELNs, labs need to inform patients about their rights and have their consent as well as take accountability and responsibility for protecting, managing, and governing data, especially if it's PHI. This ensures the company is being proactive while making big changes.

While there's positive potential for AI in labs, companies must be aware of related guidelines and standards. The U.S. has no broad, federal AI regulations. In 2022, the White House Office of Science and Technology Policy released a [Blueprint for an AI Bill of Rights](#), describing five ethical principles about ensuring systems are safe, effective, non-discriminatory, and transparent. Not only are these difficult to implement they also would be hard to track and regulate. To complicate AI regulations further, some cities and states have their own regulations they expect companies to abide by. This makes it challenging for labs to keep up and be aware of all the state laws, specifically for companies with labs across the U.S. All these unknown and unclear regulations are part of the reason so many companies are choosing to forego any big investments in technology. Some reassurance for AI/ML tools is the [FDA](#) has approved 171 "AI/ML enabled medical devices" and continue to update this list. An additional resource the FDA provides is [Guiding Principles](#) for ML. Using these resources can help comfort labs in implementing these innovative tools.

Data analytics also comes with additional guidelines and regulations. In addition to HIPPA, the World Medical Association (WMA) has a declaration based on ethical considerations regarding health databases and biobanks called the [Declaration of Taipei](#). For any data being used, it's vital to [ensure privacy and autonomy](#), especially with patient data. Companies need to be transparent about their data policies with patients, particularly when it comes to dignity, confidentiality, and discrimination. Abiding by the ethical principles and governance arrangements explained in the Declaration of Taipei will help labs feel secure in their practices with data.

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LOOKING AHEAD

Labs have immense opportunities to advance and transform their operations and more when using automation, AI, and data analytics. For the labs that have implemented these technological tools, they have seen the positive impacts while still being able to abide by ethical standards and legal regulations. Labs have exciting potential in 2024 when effectively using the right tools and technologies.

Companies need to be aware of the regulations involved with using advanced tools in their labs. There is little regulation now, so it creates hesitancy. Labs also have more complex data making it challenging to use data analytics and ML. Despite these difficulties automation, data analytics, and other tools have benefits that give labs the best chance to make breakthrough discoveries.

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