

MARCH 2024



## Science + Technology Perspectives

### Design Considerations for Building a DNA Synthesis Laboratory

Driven in part by the pursuit to create new vaccines, cures, and other breakthrough medicines, the field of cell and gene therapy has witnessed a significant surge in growth over the past few years. At the heart of many of these advancements is DNA synthesis, a process in which specific portions of the DNA strand are replicated. Because of the meticulous nature of this work, the labs must be designed and engineered to optimize worker safety, maximize efficiency, and help maintain operational continuity. If your company is considering building or renovating a lab to perform DNA synthesis, consider these key features:

- **Storage and Dispensing.** In DNA synthesis labs, dedicated storage spaces should be designed with appropriate containment measures to prevent leaks or spills, and chemical-resistant materials should be specified to maintain durability. How the chemicals are dispensed must be carefully considered. For instance, customizable distribution systems can facilitate controlled access to the chemicals, allowing the correct quantities of chemicals to be available for use while preventing unauthorized handling or exposure.
- **HVAC/Ventilation.** Along with a robust temperature, humidity, and ventilation system design, the use of airlocks and vapor barriers are two additional features that can help maintain a controlled, sterile environment and provide a safe and comfortable workspace for lab personnel. By having a dedicated space for personnel to enter and exit the lab, airlocks help minimize the introduction of particles, dust, and micro-organisms from the outside environment, enhancing the cleanliness of the laboratory. In addition, vapor barriers – impermeable layers or films applied to walls, pipes, flooring, and other surfaces that help restrict the movement of water vapor and moisture – are also necessary. These barriers are critical to maintain the proper humidity levels and avoid potential damage to equipment, reagents, and DNA samples.
- **Enclosures.** In DNA synthesis labs, isolating the critical lab equipment is another crucial design feature that can help protect both the integrity of the research process and the safety of lab personnel. Providing individual enclosures, similar to fume hoods dedicated to specific processes or equipment, can provide the necessary isolation. For example, if a synthesizer housed in an enclosure encounters a problem such as a hazardous reagent leak, that enclosure can be shut down, closed up, and properly exhausted, to avoid shutting down the entire lab and losing all in-process samples within the entire lab. Instead, only the affected enclosure would need to be addressed, while other synthesizers could continue operation.

- **Chemical Storage and Waste Management.** To minimize the risk of chemical hazards, DNA synthesis labs require proper reagent chemical storage and dispensing areas, with adequate ventilation, fire protection and spill containment measures. Safe handling of chemical waste must also be included.
- **Controls and Access.** In the design of DNA synthesis labs, controls and access play a fundamental role in maintaining the safety and security of employees as well as the physical environment itself. Control measures, such as restricted entry through keycards or biometric systems, help prevent unauthorized access and mitigate potential hazards. Alarm systems and continuous monitoring provide early detection of leaks and prompt response to protect personnel and prevent any potential contamination or damage. Interlocking doors equipped with safety controls further enhance security by restricting access to specific areas and preventing accidental exposure to hazardous materials.
- **Operational Continuity and Redundancy.** Given the financial risks associated with downtime and disruptions in the manufacturing process, several key features should be implemented in the design of a DNA synthesis lab to minimize potential losses and maintain a seamless workflow, including:
  - Backup power systems, such as Uninterruptible Power Supplies (UPS) or generators.
  - N+1 redundancy for equipment and instrument systems to serve as backups or alternatives for routine maintenance or equipment failure.
  - Efficient fault detection and alarm systems, coupled with robust maintenance protocols, to allow for quick identification and resolution of issues.

Finally, it's important to note that the technology used in the synthesis of DNA is changing as rapidly as the field itself. Because of this, a customizable, modular lab design...one that can integrate new technologies, and provides adaptable equipment arrangements...will enhance the lab's ability to stay at the forefront of DNA research and facilitate the optimal use of resources.

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## CONTACT US

Direct any comments or questions to:

**Mike Tragseiler, Director, Client Development**

[mtragseiler@hixson-inc.com](mailto:mtragseiler@hixson-inc.com)

Phone: 513.241.1230

[www.hixson-inc.com](http://www.hixson-inc.com)