

# An Automatable Approach to Ambient Nucleic Acid Storage



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## BACKGROUND

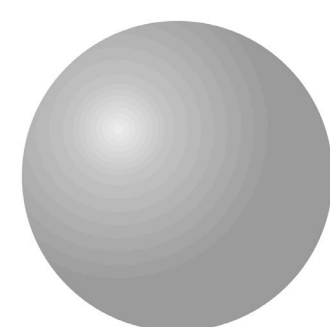
The proliferation of assays across the life sciences has increased the need for high-quality biospecimen storage methods.

Given the infrastructure costs and operational challenges of freezer-based storage, ambient preservation has been explored. However, due to issues with humidity, retrieval, and limited scalability without specialized equipment, room temperature storage has not been widely adopted.

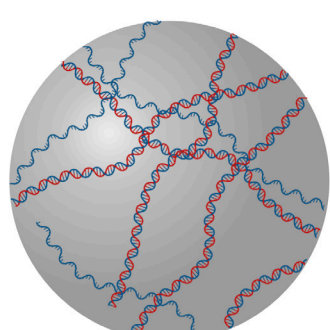
We demonstrate the feasibility of a microscale encapsulation chemistry that shields nucleic acids from environmental degradants, allowing for room temperature preservation.

This scalable approach integrates with common laboratory automation platforms at both tube- and plate-scale, requiring minimal modification to existing equipment and workflows.

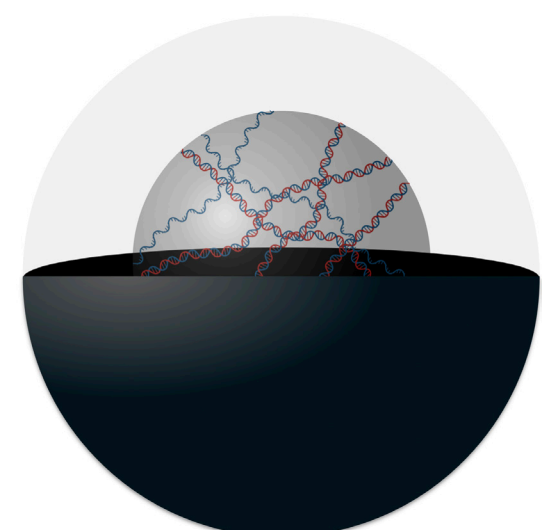
### PRESERVATION



1. Functionalized beads have a slight charge

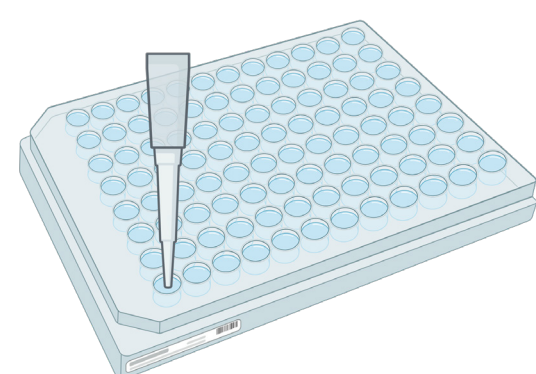


2. Nucleic acids in solution bind to the beads

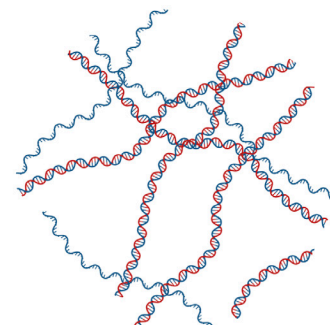


3. Encapsulants are added, forming a protective shell

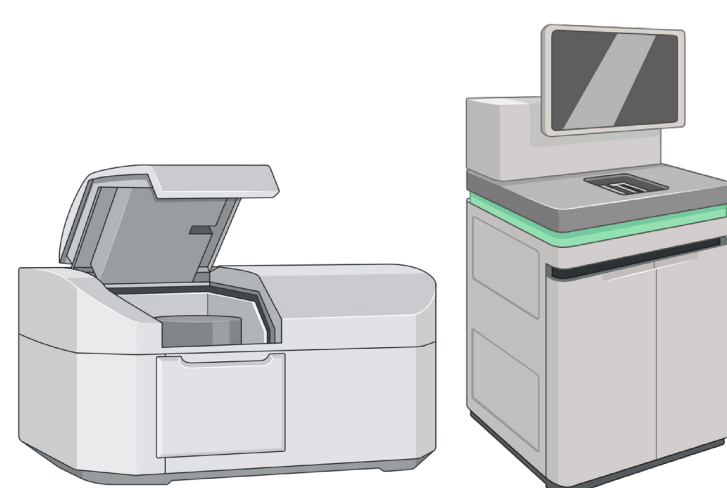
### RETRIEVAL



4. An aliquot of encapsulated beads is retrieved



5. An etching solution dissolves shell and bead



6. Nucleic acids are free to use in downstream applications (desalting may be required)

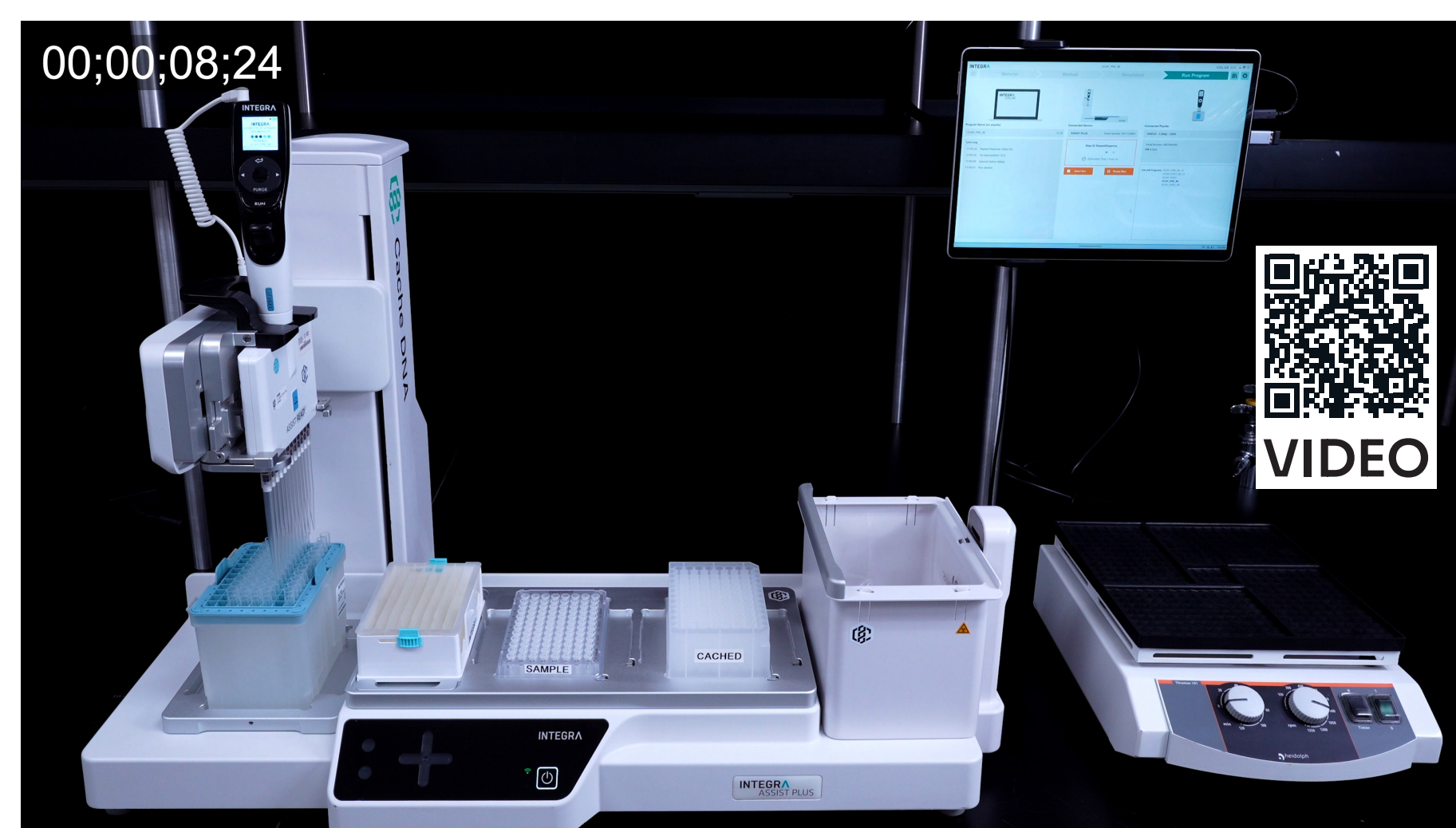
## AMBIENT AT A GLANCE

- **Ambient Preservation:** Long-term DNA and RNA storage at room temperature, with no freeze-thaws
- **High-Throughput:** Automated process compatible with any liquid handler capable of pipetting 1 mL volumes
- **Low Cost:** No costs associated with freezers, maintenance, or electricity for ongoing storage
- **Small Footprint:** 6-8x increased storage density compared to -80°C freezers, with even greater space savings if number of aliquots is reduced

## METHODS

An automated implementation of ambient nucleic acid preservation was developed and tested across multiple liquid handling platforms.

- Manual protocol was translated to automated methods compatible with commercial liquid handling platforms (Integra ASSIST PLUS, Hamilton Microlab Prep/STAR)
- An automated quality control assay was developed using Lambda DNA standards with Qubit fluorometric quantification pre- and post-preservation
- Protocol performance on the ASSIST PLUS was evaluated through repeated quality control assay runs measuring sample recovery rates
- Process timing was characterized for 96-well plate processing on the ASSIST PLUS and Microlab STAR, and theoretical throughput was calculated for 12- and 96-channel liquid handler configurations

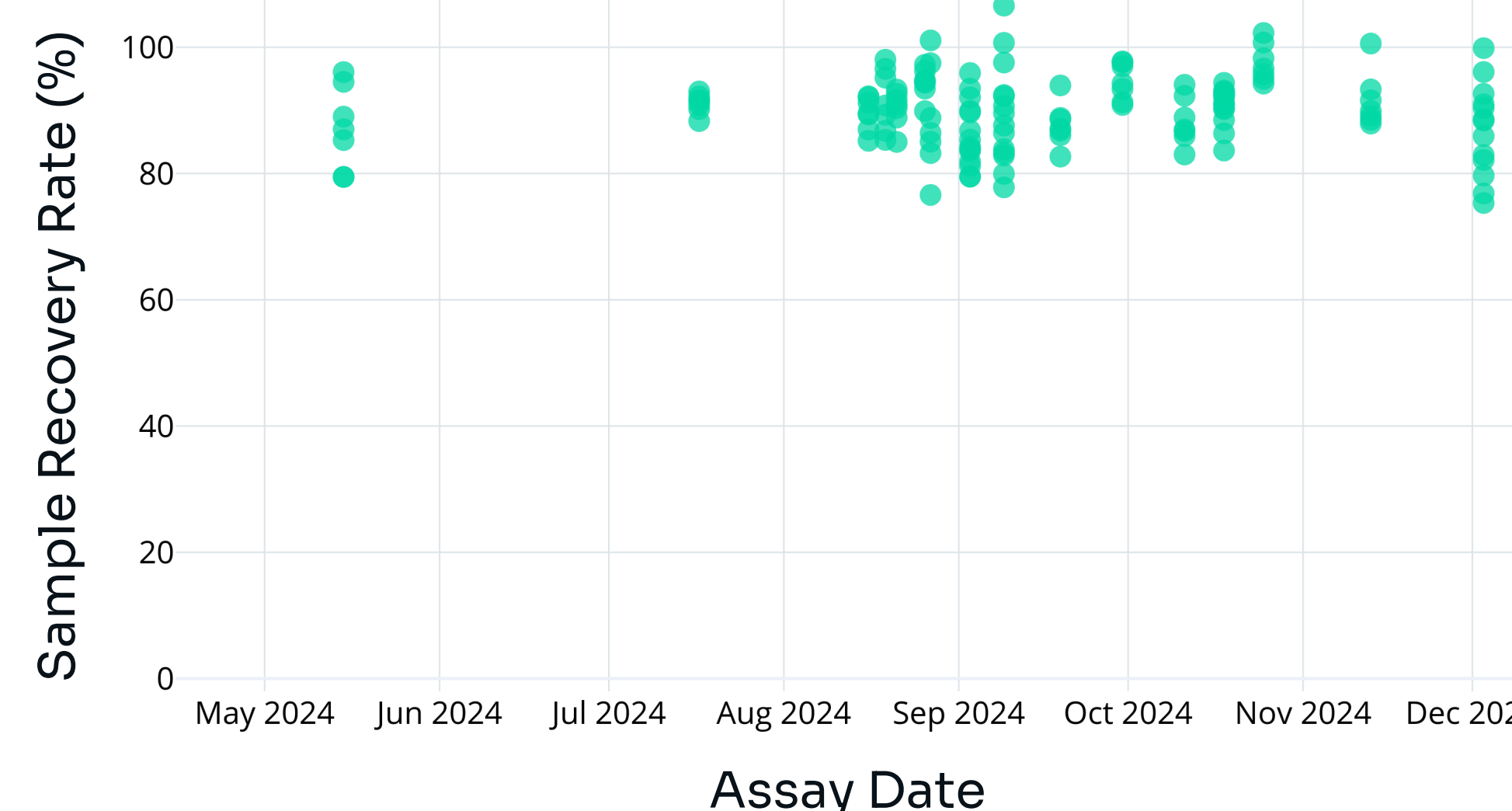


Integra ASSIST PLUS setup for processing 96 samples

## RESULTS

- Quality control testing on the ASSIST PLUS using Lambda DNA standards (1 µg/reaction) demonstrated consistent recovery performance, with a **mean recovery rate of 90.0%** across **20 independent runs over eight months** (SD = 5.7%, n = 139 samples)
- Process characterization showed the Integra ASSIST PLUS 12-channel system processes one 96-well plate in 62 minutes (32m preservation, 30m retrieval), achieving estimated throughput of **7+ plates/day**
- The 96-channel Hamilton Microlab STAR was shown to be capable of processing four 96-well plates in 46 minutes (23m preservation, 23m retrieval), enabling estimated throughput of **40+ plates/day**
- Implementation required **no specialized equipment** beyond standard liquid handlers and laboratory infrastructure

### AUTOMATED QC ASSAY RESULTS



## CONCLUSIONS

- This automatable approach enables **seamless integration** of ambient storage into **existing liquid handling workflows** while maintaining consistent sample recovery rates across varying scales of operation
- The low reagent costs and elimination of freezer infrastructure, monitoring systems, and backup power requirements suggest **substantial long-term cost savings**
- Integration with common liquid handling platforms requires **minimal workflow modification**, facilitating adoption by automated laboratories

## FUTURE WORK

Future development will focus on:

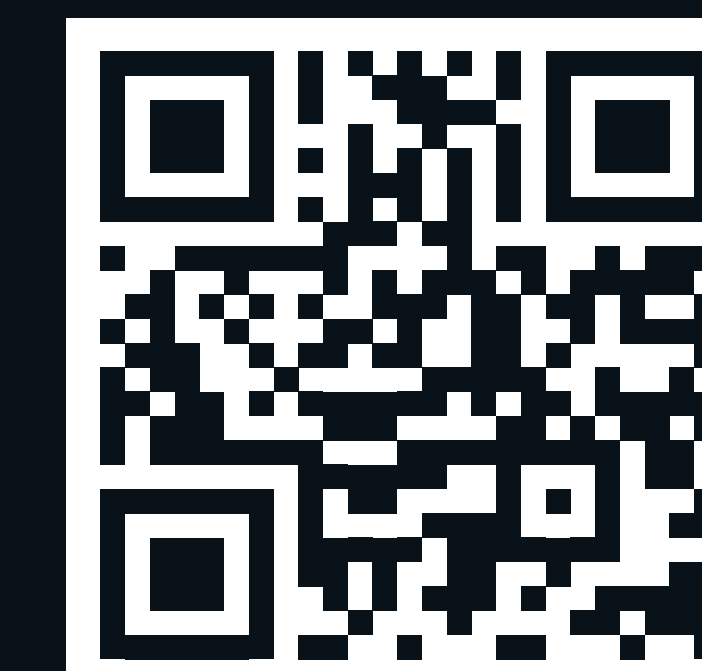
- Expanding throughput capacity and testing on additional laboratory automation systems
- Demonstrating broad compatibility with upstream extraction and downstream analysis protocols
- Streamlining reaction steps to further decrease processing time
- Validating the method in more automated workflows and equipping labs with ongoing reagent/consumable supply stream necessary to store and retrieve samples



Hamilton Microlab STAR processing 384 samples across four plates

### CONTACT US

- Reach out to us at with any questions at [hello@cache-dna.com](mailto:hello@cache-dna.com)
- Visit our website at [www.cache-dna.com](http://www.cache-dna.com)



### ACKNOWLEDGEMENTS

- Spaero Bio for the use of their Hamilton Microlab STAR

### ADDITIONAL MATERIALS

Peer-reviewed publications on proof-of-concept:

[10.1021/acsami.1c14985](https://doi.org/10.1021/acsami.1c14985)

Storage of genomes & RNA

[10.1038/s41563-021-01021-3](https://doi.org/10.1038/s41563-021-01021-3)

Random access retrieval

[10.1016/j.tig.2024.11.012](https://doi.org/10.1016/j.tig.2024.11.012)

Ambient genomic time capsules