

SEMI-PERMEABLE CAPSULES ENABLE A HIGHLY VERSATILE AND ROBUST ANALYSIS OF SINGLE-CELL GENOMES, TRANSCRIPTOMES, AND EPIGENOMES

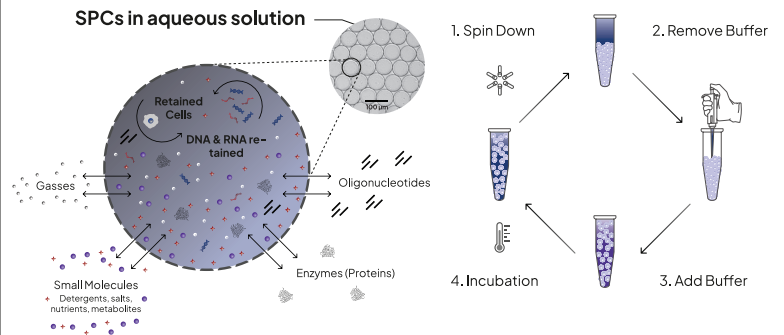
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INTRODUCTION

Over the last decade, we witnessed an explosion in single-cell -omic technologies using sequencing as a readout and keep observing the advances they brought in fundamental and applied research. To satisfy the need to study thousands of individual cells per sample, well-, droplet-, and fixation-based approaches keep evolving in parallel to provide the single-cell compartmentalization required during sequencing library preparation. However, these approaches suffer from a fundamental trade-off between throughput and versatility. Being individually addressable, microwells enable multi-step processing but are not scalable. Droplet- and fixation-based methods offer a throughput of up to a million cells per experiment but only allow a limited number of processing steps to be performed. Our **semi-permeable capsule (SPC) technology** combines the throughput of droplets with the versatility of wells by enabling a virtually unlimited number of processing steps on genetic material from millions of individual cells in parallel.

TECHNOLOGY



RESULTS

GENERAL PROPERTIES

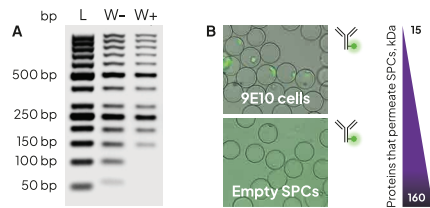


Figure 1. SPC permeability to biomolecules. (A) dsDNA retention (L: DNA ladder; W-: dissolved SPCs without washes; W+: dissolved SPCs after 1-hour washing in aqueous buffer). (B) Protein permeability.

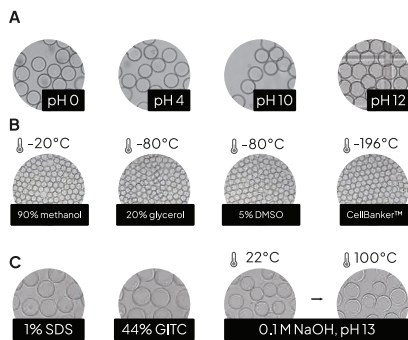


Figure 2. SPC stability. (A) SPCs after 1-hour incubation in solutions with various pH values. (B) SPCs after 1 month of storage in different cryoprotectants. (C) Simulation of harsh cell lysis conditions.

MOLECULAR BIOLOGY

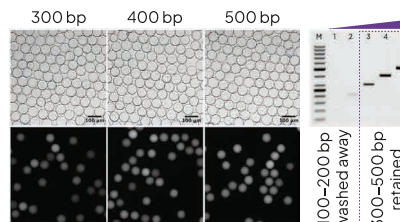


Figure 3. PCR performed in SPCs on cell lysates, producing different amplicon lengths.

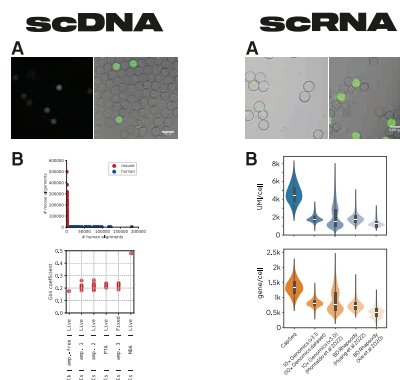


Figure 4. Single-cell WGS. (A) Encapsulated GM1287 cells after lysis (left) and after WGA in SPCs (right). (B) scWGS on human and mouse cells.

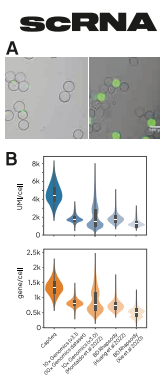


Figure 5. Single-cell RNA-seq. (A) Encapsulated K562 cells (left) and amplified cDNA after RT-PCR in SPCs (right). (B) scRNA-seq on PBMCs [1].

CELL CULTIVATION

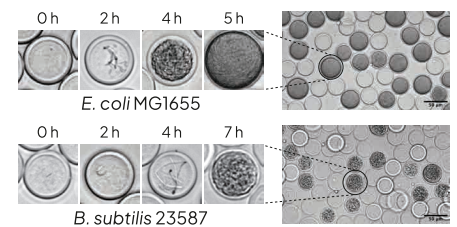


Figure 6. Bacterial cell growth in SPCs. Cells were incubated in LB medium at 37°C.

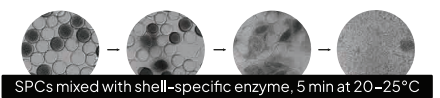


Figure 7. SPC dissolution at mild conditions. Encapsulated *E. coli* cells remain intact and viable.

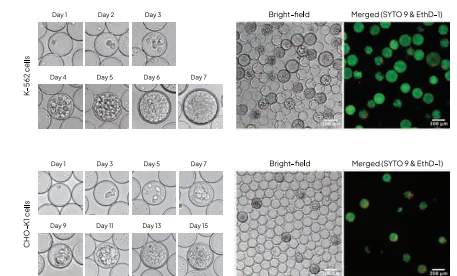


Figure 8. Formation of spheroids from individual encapsulated mammalian cells in SPCs. Cells were incubated at 37°C in 5% CO₂.

CONCLUSIONS

- SPCs effectively isolate individual cells and retain their genomic DNA and mRNA.
- Chemical and thermal stability enables cell lysis under harsh conditions, maximizing access to cellular genetic material.
- Size-selective permeability to biomolecules allows biochemical reactions to occur under optimal conditions.
- Effective diffusion of nutrients and metabolites supports robust cell growth within SPCs.
- Miniature size makes SPCs an attractive tool for developing affordable, ultra-high-throughput single-cell workflows.

REFERENCES

1. Baronas D, Zvirblyte J, Norvaisis S, et al. High-throughput single cell -omics using semi-permeable capsules. bioRxiv (2025)

TRADEMARKS

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