Enabling single cell research in hollow hydrogel microparticles

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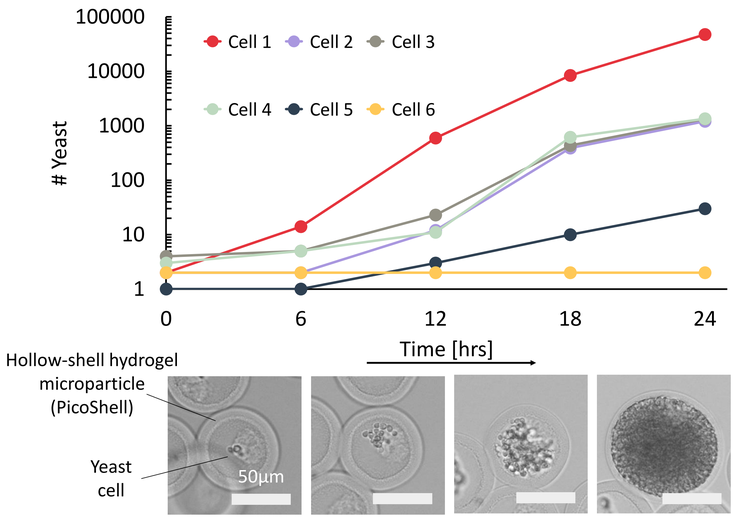
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Background

- **Opportunity:** Easily study single cells in high throughput to explore population heterogeneity. Possible automation.
- **How:** Hydrogel microparticles (~70um diameter) with a hollow liquid core containing a single cell (PicoShells). PicoShells can be desiccated for transport and storage.
- **Why PicoShells?** Isolate single cells, their progeny, and their secretions from each other, allowing each cell to be separately analyzed.

Single cell analysis example

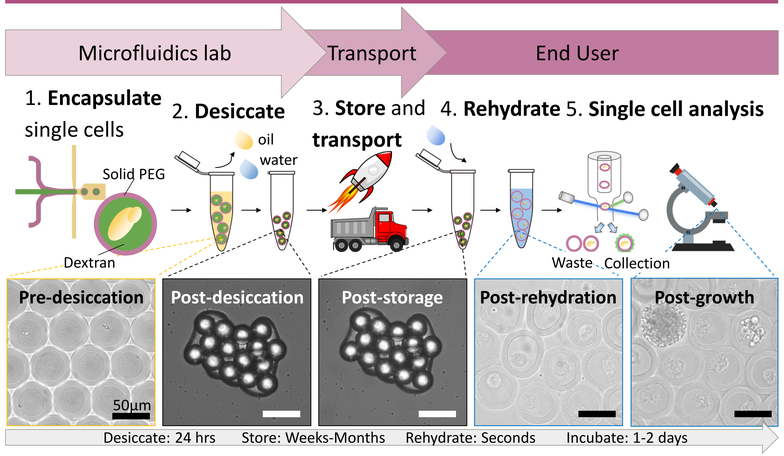


Assay growth of single cells through time to evaluate fitness. *Saccharomyces cerevisiae* in PicoShells grow until they physically stretch the particle wall (see panel).

Why desiccate?

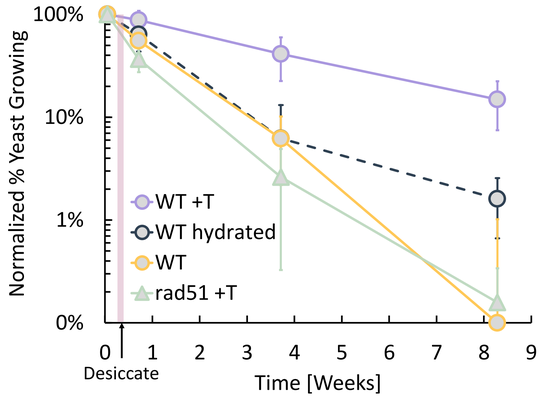
- **Easily store and transport particles with cells to any lab**, on Earth or in space.
  1. **Particle fabrication is difficult.** Encapsulating single cells in particles requires expensive microfluidic equipment and specialized fabrication techniques.
  2. **Desiccated particles could be flown to space.** Missions including BioSentinel and BioNutrients desiccate their yeast to increase shelf-life and robustness during launch.
- **An ideal desiccation process should change nothing -** no changes to yeast health/behavior or particle properties.

Desiccation method



After microfluidic encapsulation in oil, PicoShells with cells are desiccated under vacuum for 24 hours to leave shelf-stable particles, which can be transported and stored before rehydration to begin study.

Changes due to desiccation



Wild type yeast desiccated with 10% trehalose maintain highest growth after 8 weeks of storage compared to non-desiccated yeast, yeast desiccated without trehalose, and mutant *rad51* yeast desiccated with trehalose.

Future directions

- **Automated multi-step assay:** Leverage porous hydrogel shell to change the solution inside the particle. Automate assays like PCR, ELISA, etc on rehydrated particles.
- **Sort cells:** Use a flow sorter to isolate specific subpopulations based on secretions or other assay results.
- **Send desiccated particles with cells to space!**

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