Robotics and AI for Synthetic Cells Production

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CONTROLLED RELEASE SOCIETY
CRS 2024 Annual Meeting AND Exposition
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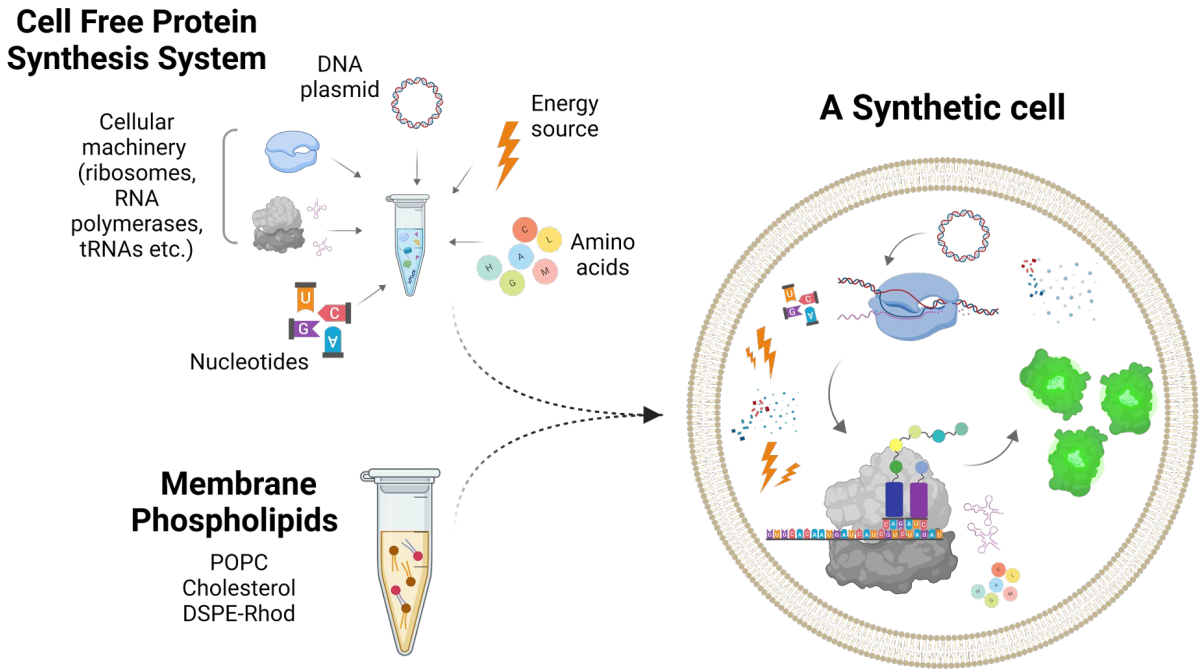
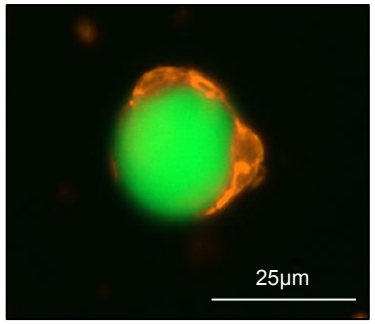
INTEGRATING
Delivery Science
ACROSS DISCIPLINES

Synthetic Cells

Synthetic cells are artificial particles, constructed to mimic the behavior, function, and structure of living cells

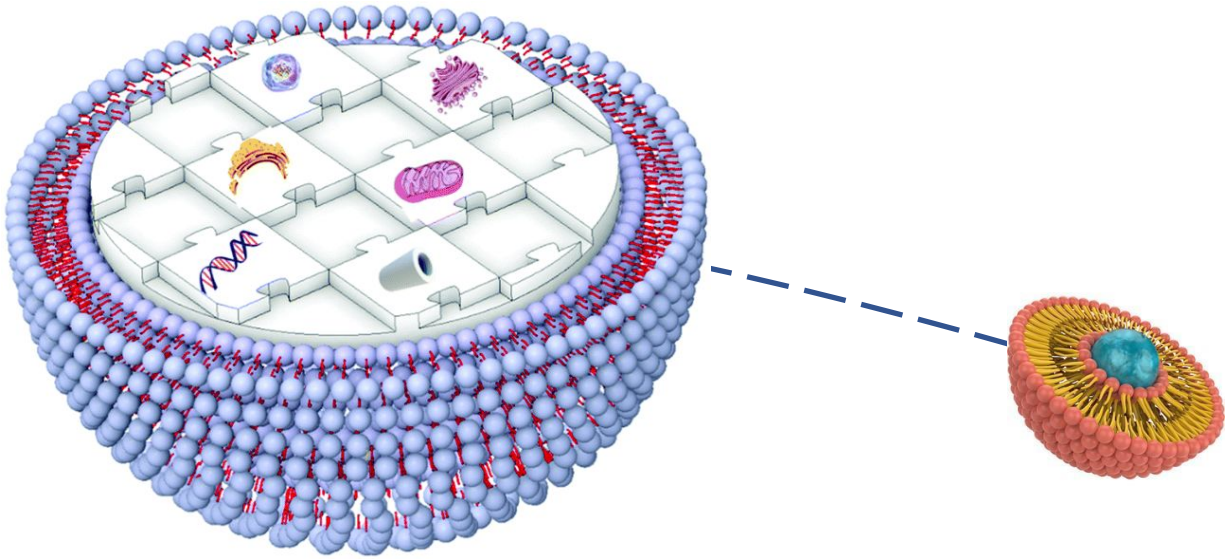




GFP –produced inside the SCs
Rhodamine- membrane label

Applying Synthetic Biology to Drug Delivery

Natural Cell

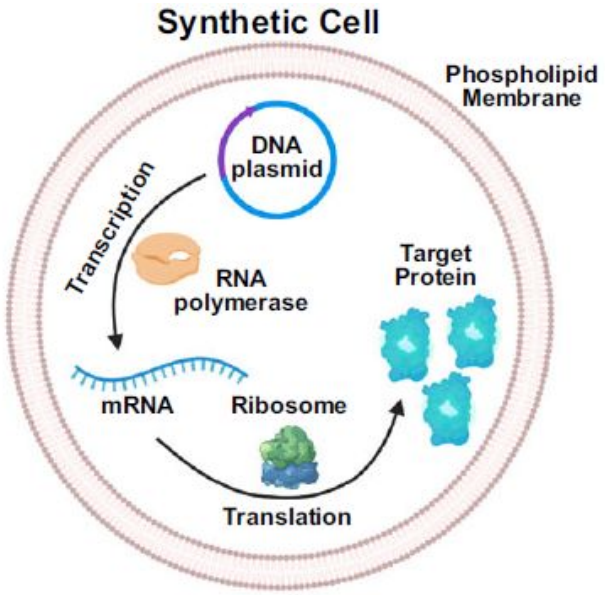


Synthetic Cell

Nanoparticle

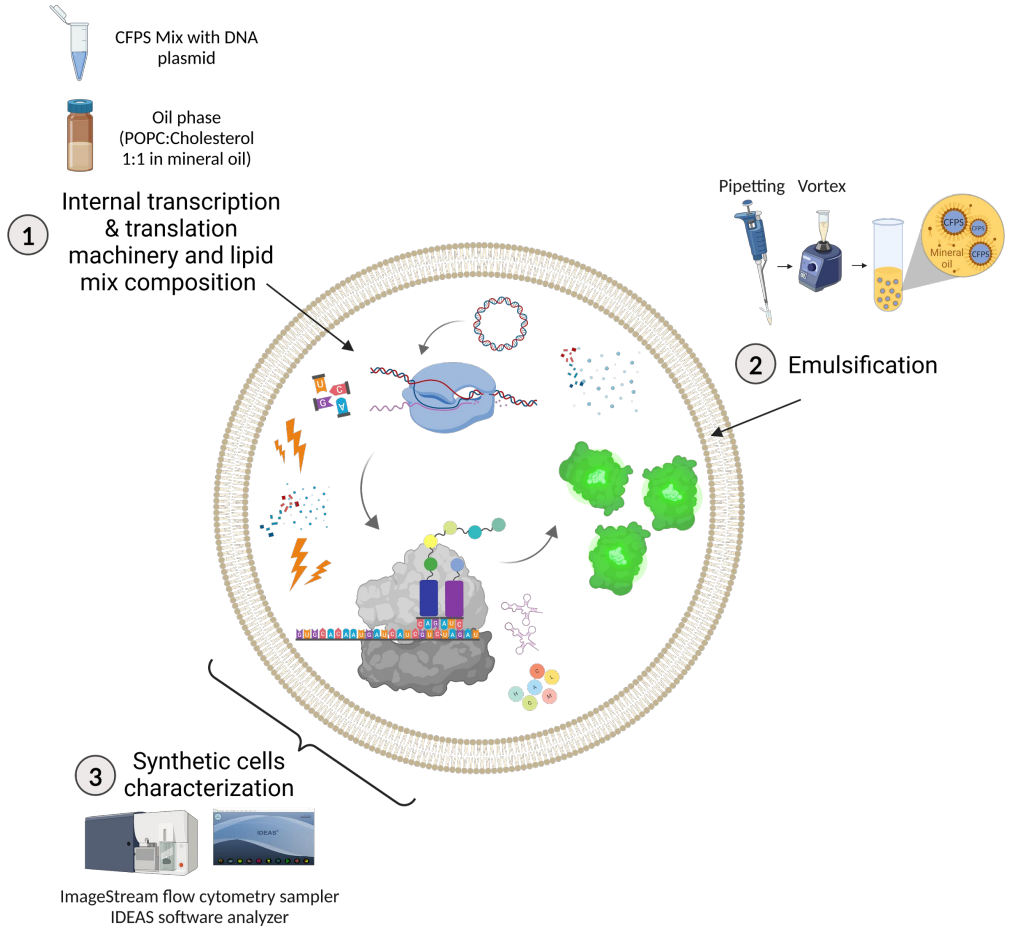
Diltemiz, S.E., et al. Cell (2021).

Responsiveness in Synthetic Cells



Adir, O., et al. (2022). Nat. Commun.

Key Steps in Synthetic Cells (SCs) Production



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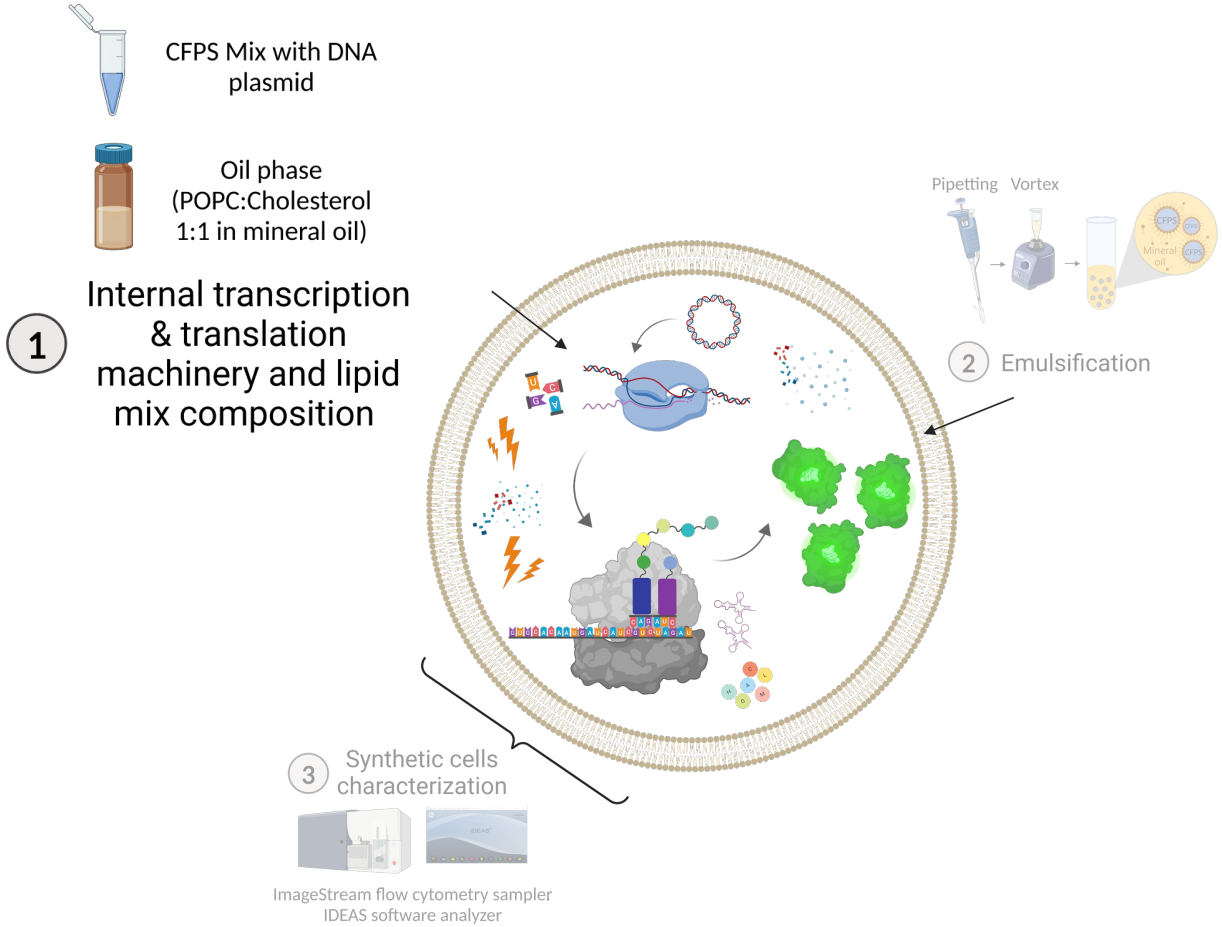
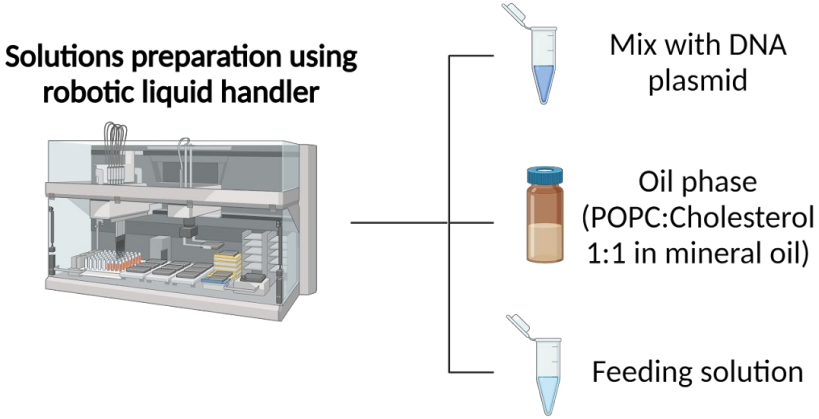


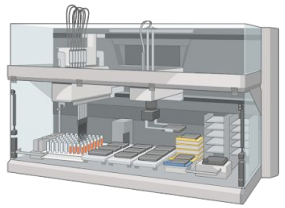
Liquid Handler for Automated Solution Assembly

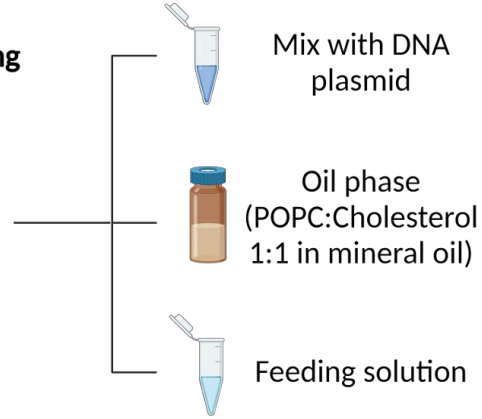


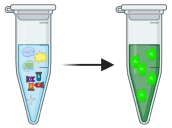
Ackerman, S. et al. (in preparation)

Liquid Handler for Automated Solution Assembly

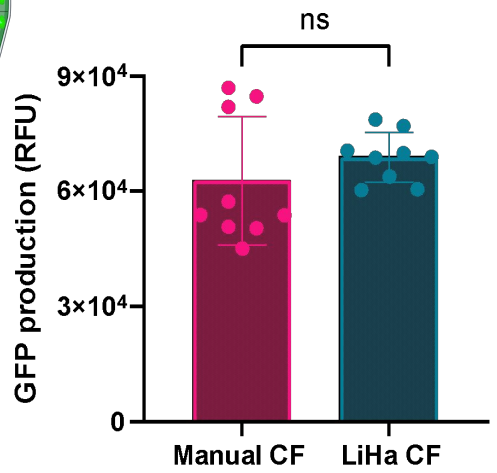
Solutions preparation using robotic liquid handler







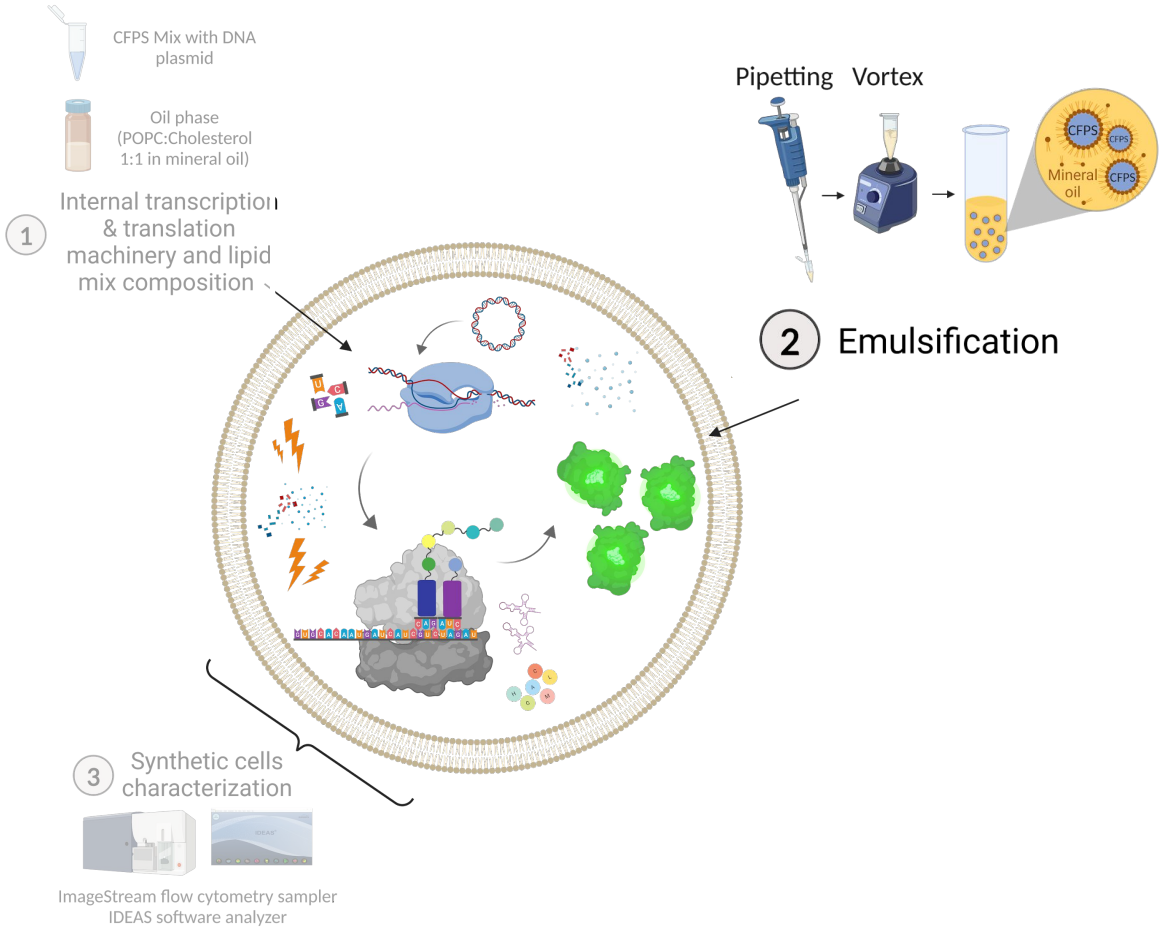
Cell free sfGFP production:



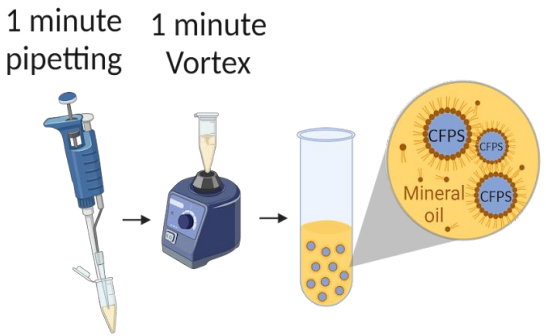
- ✔ **Equal activity**
- ✔ **Better uniformity**

Ackerman, S. et al. (in preparation)

Key Steps in Synthetic Cells (SCs) Production



Automated Emulsification for Scale-Up SCs production

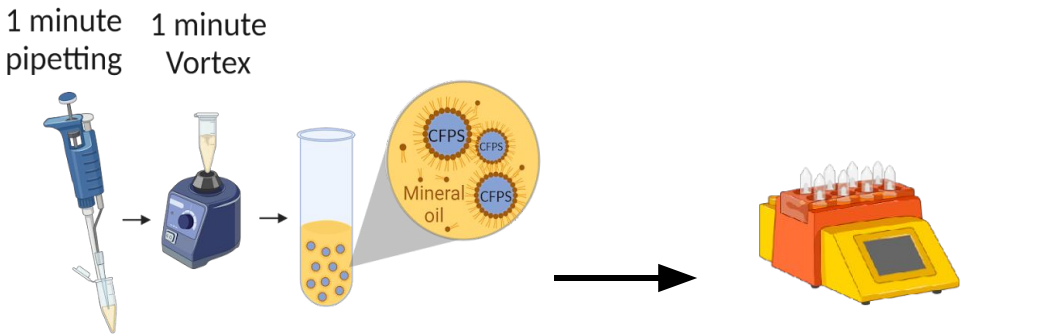


Pipetting and vortex

☒ Laborious, not consistent, limited in volume, time consuming

Ackerman, S. et al. (in preparation)

Automated Emulsification for Scale-Up SCs production



Pipetting and vortex

☒ Laborious, not consistent, limited in volume, time consuming

GentleMACS

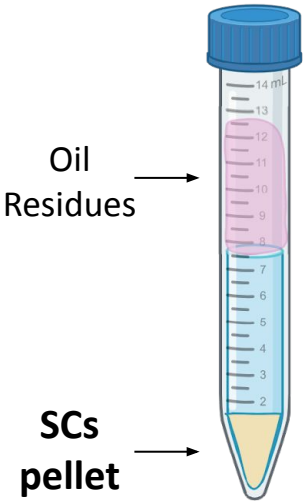
☑ Fast, easy to use, consistent, suitable to high volumes

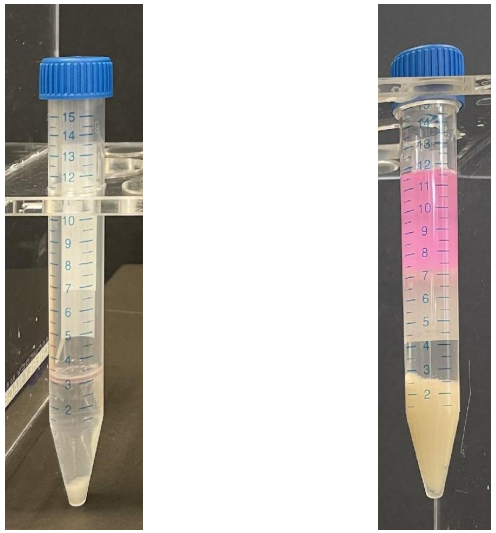
Ackerman, S. et al. (in preparation)

Automated Emulsification for Scale-Up SCs production

100ul Manual SCs

3ml GentleMACS SCs





x30

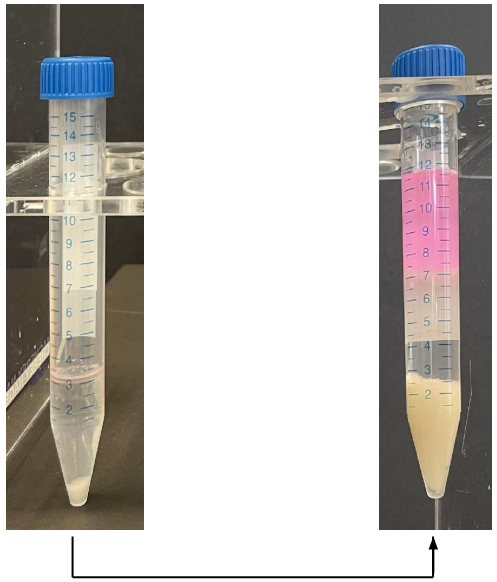
Ackerman, S. et al. (in preparation)

Automated Emulsification for Scale-Up SCs production

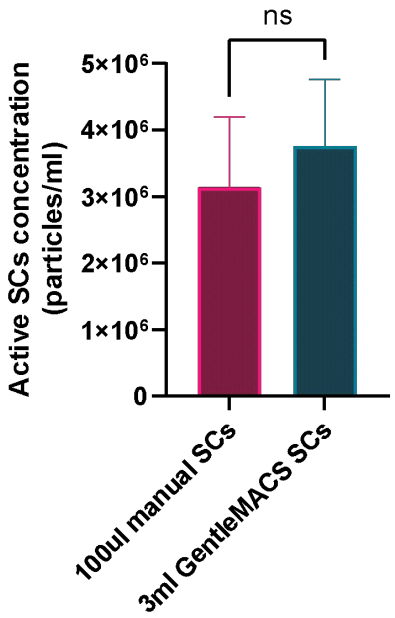
- ✔ Equal concentration and size
- ✔ Quick
- ✔ Unlimited amounts

100ul Manual SCs

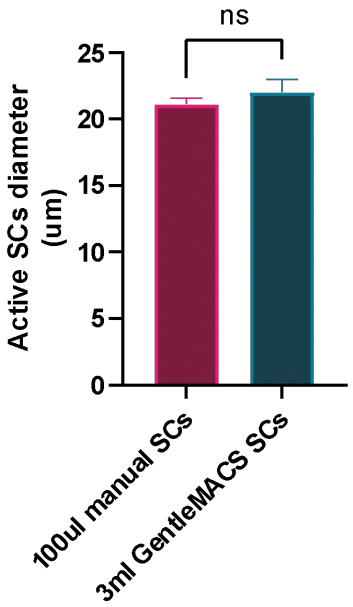
3ml GentleMACS SCs



Active SCs concentration:



Active SCs diameter:



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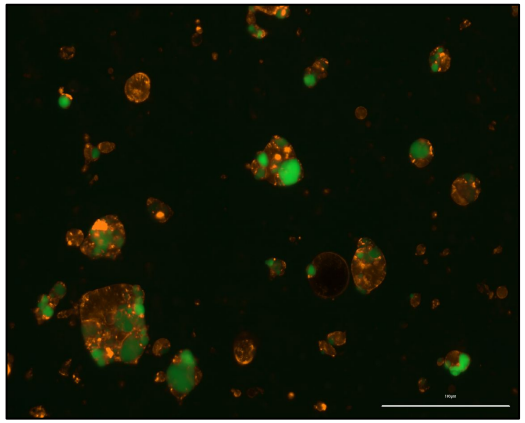
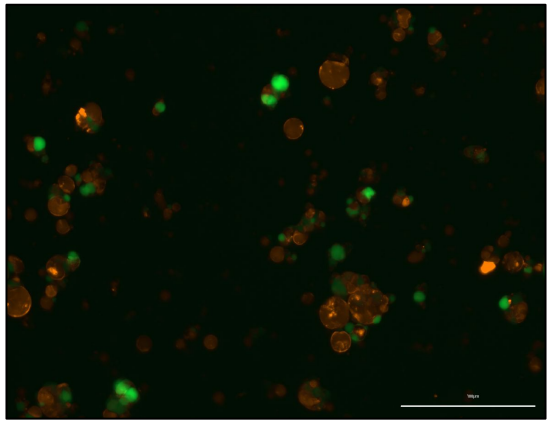
Automated Emulsification for Scale-Up SCs production

100ul manual SCs:



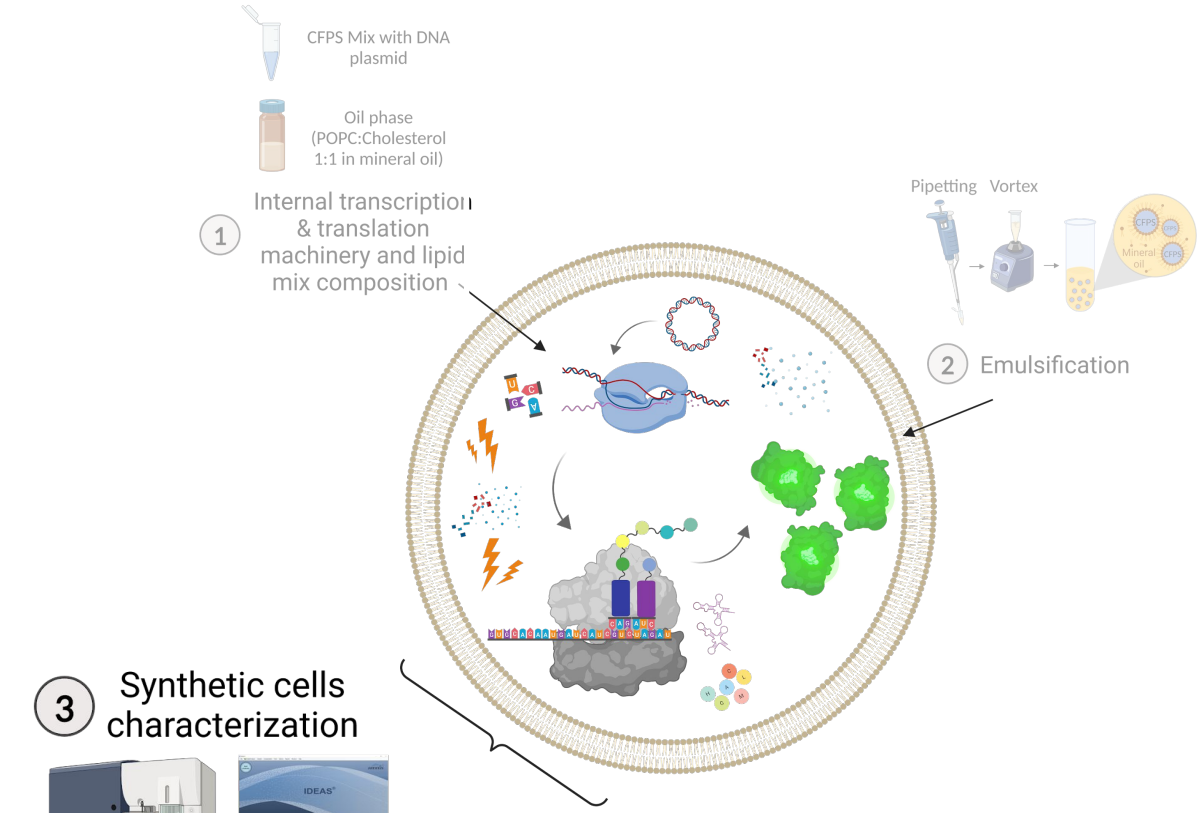
3,000ul SCs using **GentleMACS**:



GFP –produced inside the SCs, **Rhodamine-** membrane label

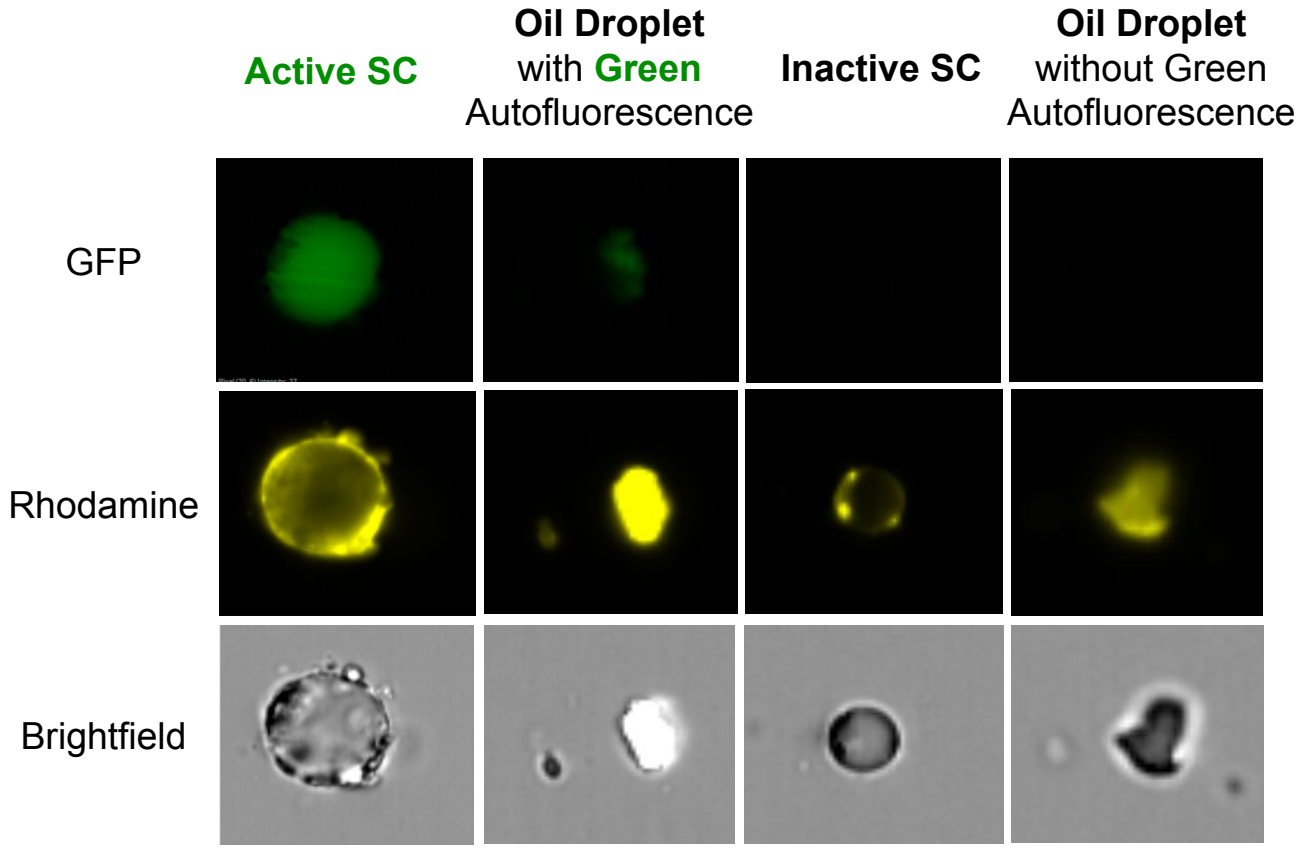
Ackerman, S. et al. (in preparation)

Key Steps in Synthetic Cells (SCs) Production



ImageStream flow cytometry sampler
IDEAS software analyzer

SCs Characterization



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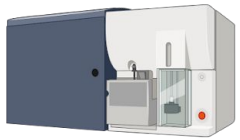
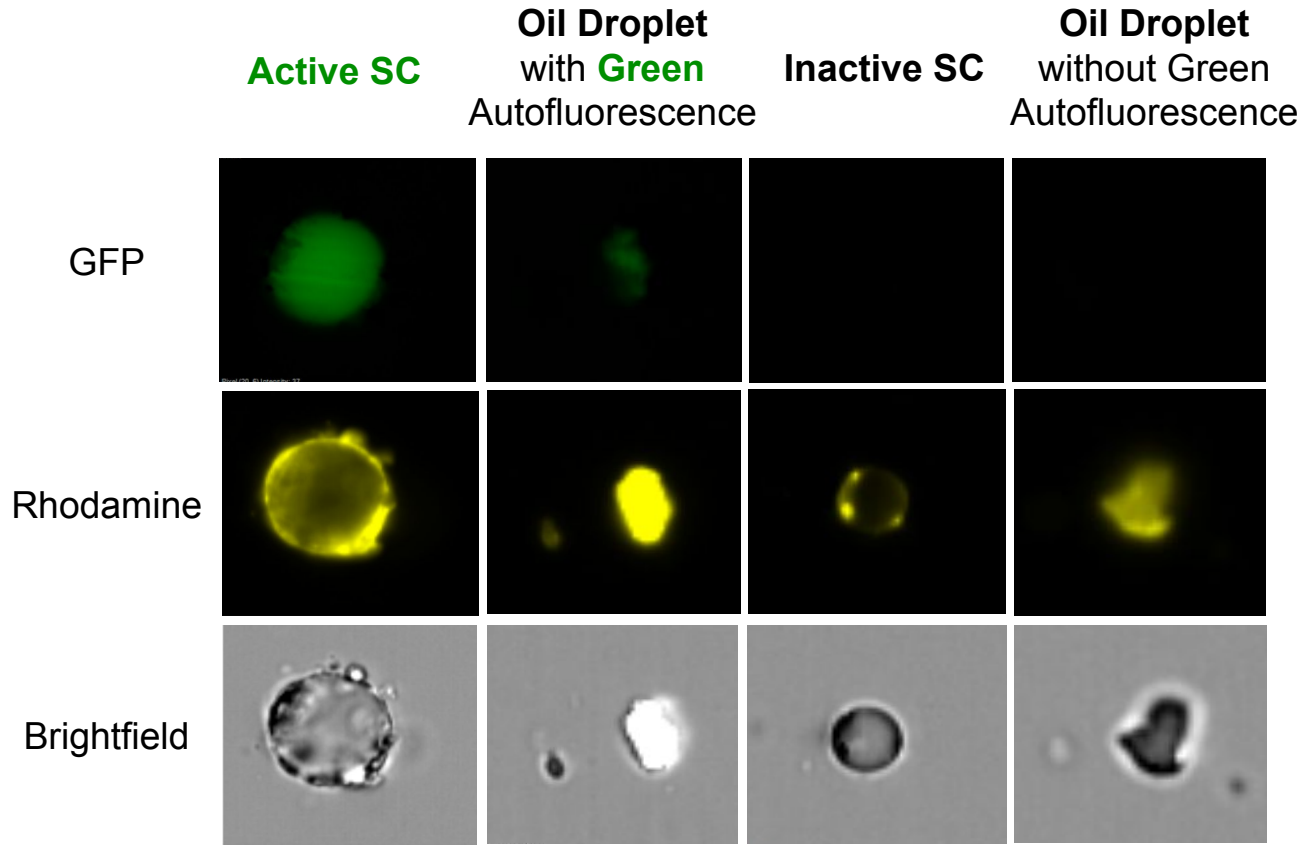
SCs Characterization



Imagestream analysis

IDEAS software



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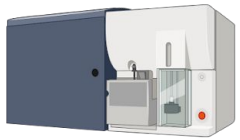

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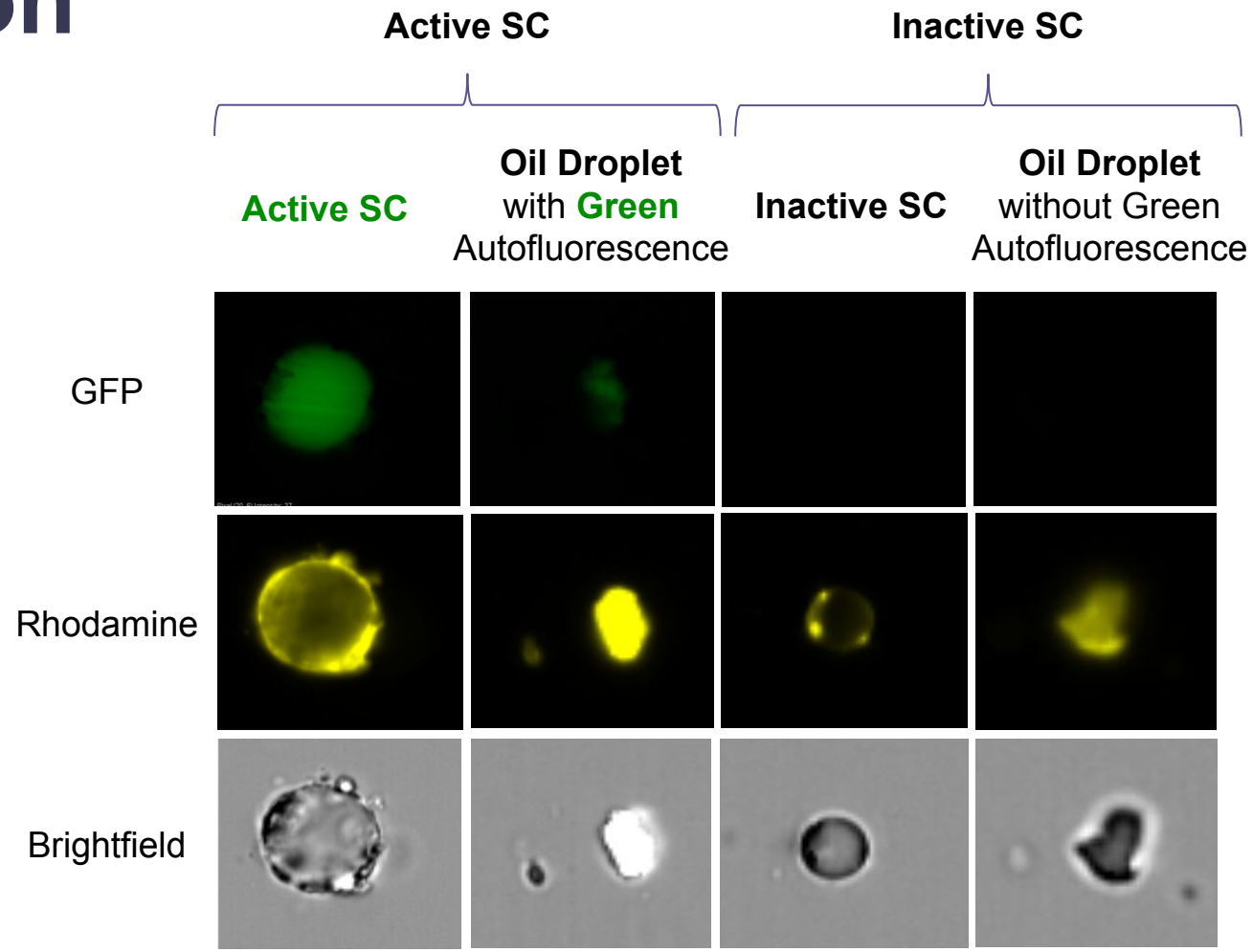

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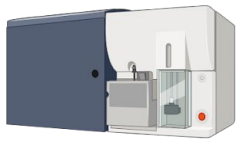

Imagestream analysis

IDEAS software

Manual SC counting

- ☒ Time consuming, not consistent

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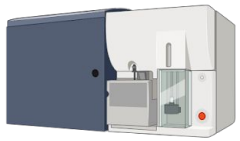
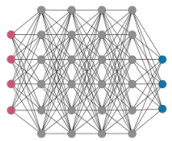
SCs Characterization Using Deep Neural Networks



Imagestream analysis



Neural network (AI) analysis

3-class classification:

- **Active SCs**
- **Inactive SCs**
- **Oil Droplet** with / without **Green** Autofluorescence

Ido Galil

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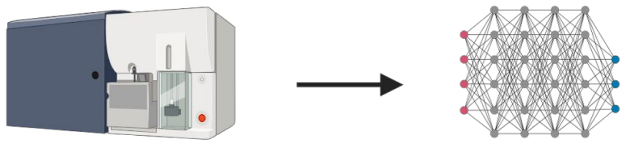
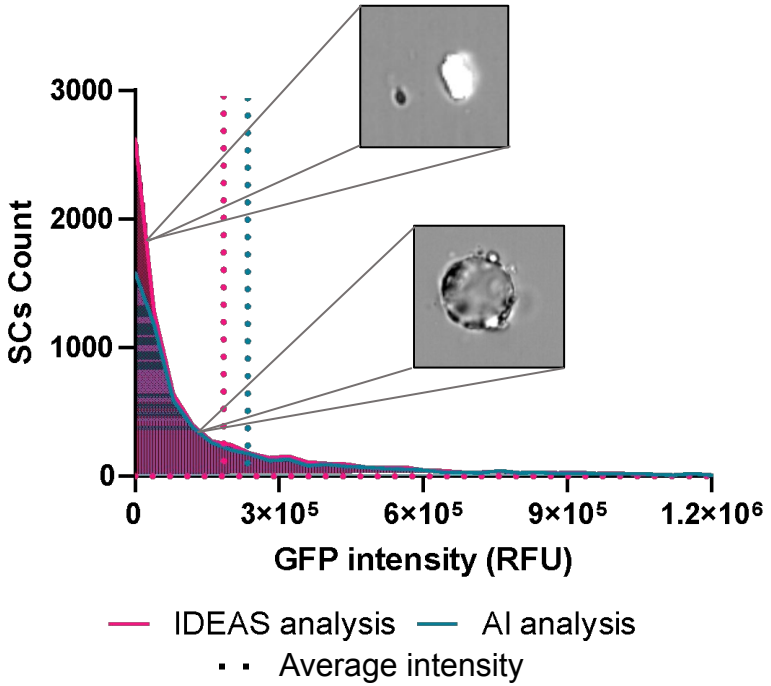
SCs Characterization Using Deep Neural Networks



Imagestream analysis

Neural network (AI) analysis

Intensity distribution of GFP producing SCs:



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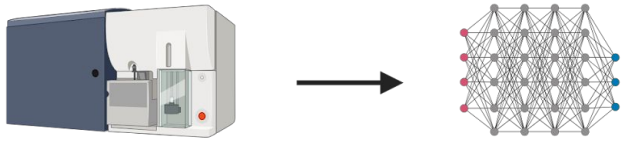
SCs Characterization Using Deep Neural Networks



Imagestream analysis

Neural network (AI) analysis

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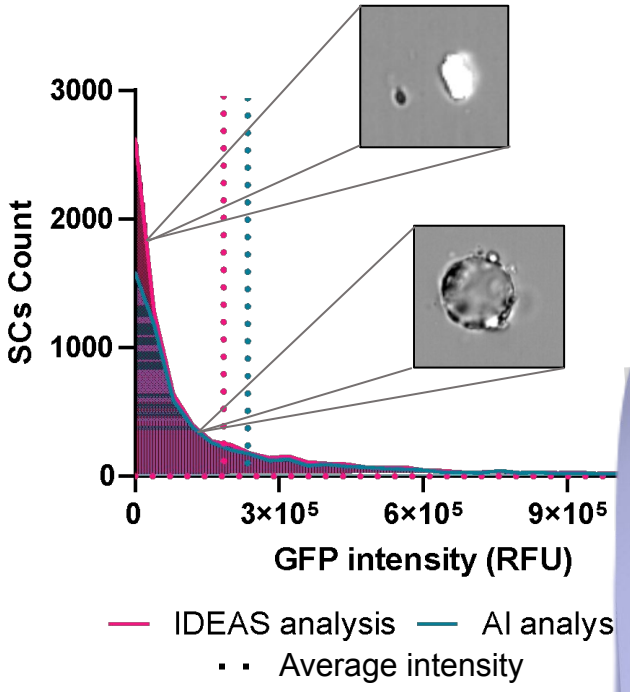

- ✔ Fast
- ✔ Accurate
- ✔ Data analysis at a large scale

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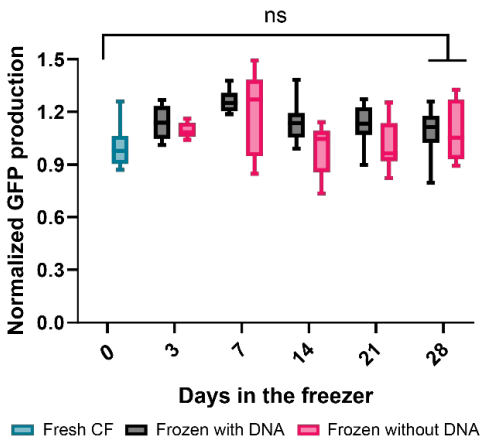
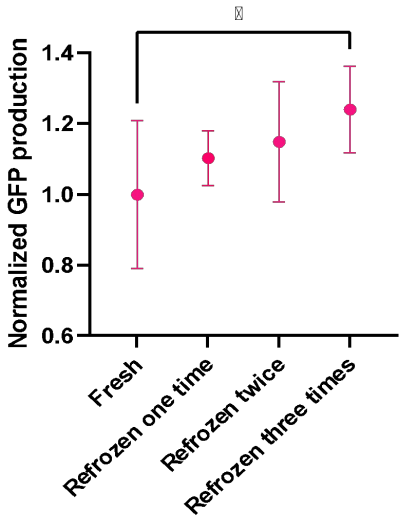
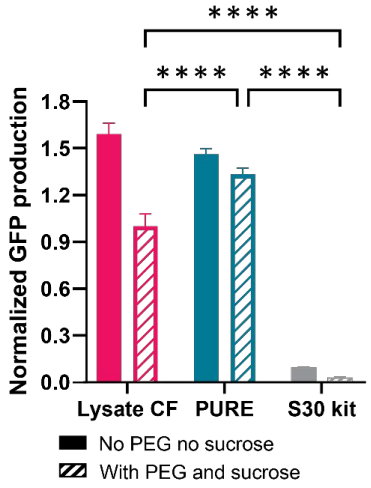
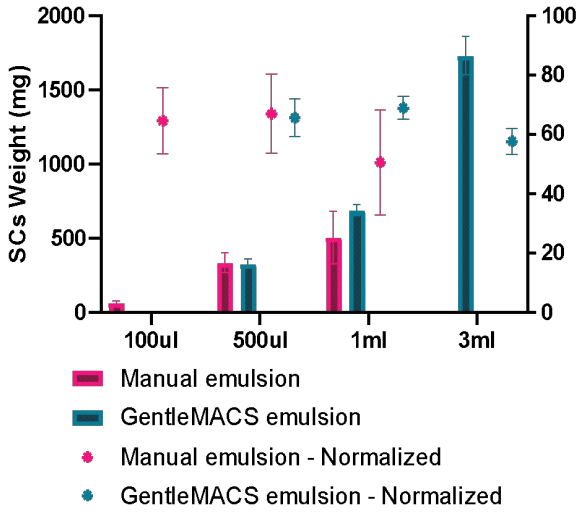
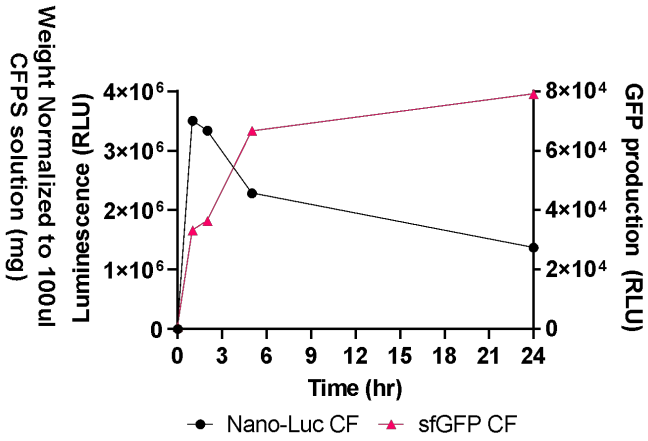
Poster 1185

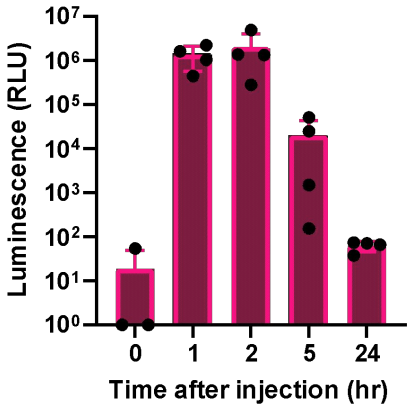


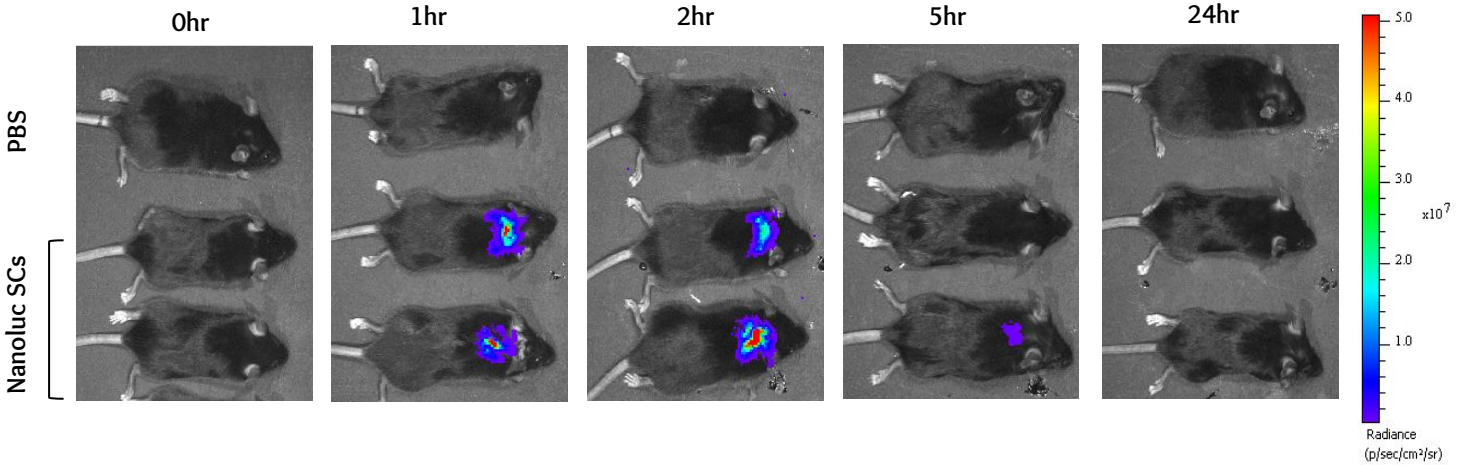


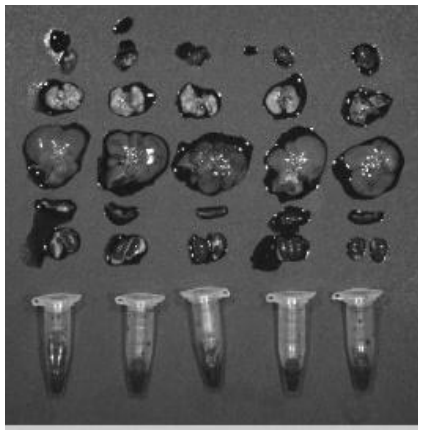












Ackerman, S. et al. (in preparation)

Summary

Automation of all 3 key steps in synthetic cells production:

- Using a **Liquid handler** for **uniform solution preparation**
- Using **GentleMACS** for the production of **unlimited amounts** of SCs
- Using **Neural network** analysis for **large-scale and accurate characterization**

Acknowledgement

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Ido Galil

Omer Kfir

Dr. Patricia Mora-Riamundo

Schroeder lab members

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