Marcus Fletcher

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Selected Research Experience

PDRA in Artificial Cell Engineering (Imperial College London) **09/2022 – Current**
Supervisor: Dr Yuval Elani

- Developed **first platform** for continuous production of cell-sized **lipid vesicles** with **varying lipid compositions** using **microfluidics**.
- Invented a **new simple to use technique** for **quantifying cell surface charge** potentials using fluorescent **DNA based sensors**.
- Invented a microfluidic technique for connecting microfluidic devices in a pressure de-coupled modular fashion, negating the need for time-costly re-design when integrating devices (publication in prep).
- **Researcher Co-Investigator** for **BBSRC Transformative Research Technologies 23 grant.** Conceived the project idea and wrote grant application for awards of **£250k**. 12 month project outcomes include **3 publications**, an active PhD project extending this work, and **two publications in preparation**.
- Developed OpenAI **gym style framework** for training **vision based reinforcement learning** controllers for microfluidics.
- Pioneered **robust two-photon lithography** fabrication of microfluidic moulds **using NanoScribe**.

PhD Candidate in Biophysics *(University of Cambridge)* **10/2018 – 11/2022**
Supervisor: Prof. Ulrich Keyser

Thesis: Quantification of membrane transport rates using optofluidics.

- Designed new techniques to sequentially build artificial cell membrane models and sense transmembrane ion transport optically, combining **novel microfluidics** and DNA nanotechnology.
- Developed **computer vision suite** for analysing optical membrane permeability experiments, including a GUI for visualizing analysis sub procedures.
- Established experimental methods and software for studying the controlled fusion of oppositely charged lipid membranes.
- Designed a **theoretical simulation** of the ion transport process for elucidating mechanisms behind transport experiments.
- **Trained neural networks** for fast high accuracy detection of single vesicles within microfluidics
- Engineered **robotic microfluidic** and microscopy setup for collecting training data for microfluidics control.
- Demonstrated a microfluidic process for the reconstitution of OmpF protein into Giant Unilamellar Vesicles

Peer-Reviewed Publications

1. **Fletcher M.**, Diggines B., and Elani Y., "Molecular Systems Engineering of Synthetic Cells. *Nat. Chem.* **18**, 14–22 (2026). https://doi.org/10.1038/s41557-025-02019-z
2. **Fletcher M.**, Elani Y., Keyser U. F., and Tivony R., "Studying cellular ion transport mechanisms using giant unilamellar vesicles" *Biophysical Reviews* 2025, DOI: 10.1007/s12551-025-01342-6. **Corresponding author**
3. **Fletcher M.,** and Elani Y., "On-the-Fly Microfluidic Control of Giant Vesicle Compositions Validated by DNA Surface Charge Sensors", *ACS Nano* 2025, 19, 14, 13768-13778.
4. **Fletcher M.**, Tivony R., Al Nahas K., and Keyser U. F., 'DNA based optical sensing for quantification of potassium transport across giant vesicles.', *ACS Nano* 2022, 16, 10, 17128–17138.
5. Tivony R.[⊥], **Fletcher M.**[⊥], Al Nahas K., and Keyser U.F., 'A microfluidic platform for sequential assembly and separation of synthetic cell models.', *ACS Synthetic Biology* **2021** *10* (11), 3105-3116 DOI: 10.1021/acssynbio.1c00371

6. Hammond K., Cipcigan F., Al Nahas K., Losasso V., Lewis H., Cama J., Martelli F., Simcock P. W., **Fletcher M.,** Ravi J., Stansfeld P. J., Pagliara S., Hoogenboom B. W., Keyser U. F., Sansom M. S. P, Crain J., and Ryadnov M. G., *ACS Nano* **2021** *15* (6), 9679-9689 DOI: 10.1021/acsnano.1c00218

7. Knowles S. F., **Fletcher M.**, Mc Hugh J., Earle M., Keyser U.F.and Thorneywork A. L., 'Observing capture with a colloidal model membrane channel', *J. Phys.: Condens. Matter, 34 (34), 344001.*

8. Al Nahas, K.; **Fletcher, M.**; Hammond, K.; Nehls, C. ; Cama J.; Ryadnov, M.; Keyser, F U., "Measuring thousands of single vesicle leakage events reveals the mode of action of antimicrobial peptides", *Analytical Chem. 94, (27), 9530-9539.*

9. Cama J., Al Nahas K., **Fletcher M.**, Hammond K., Ryadnov M., Keyser U. F. and Pagliara S*, '* An ultrasensitive microfluidic approach reveals correlations between the physico- chemical and biological activity of experimental peptide antibiotics' *Sci Rep* ***12****, 4005 (2022).*

⊥ indicates co-first authors

Conference presentations and Invited talks

Conference talks & poster presentations

- SynCell 2024 (Accepted talk)
- German Biophysics Society Meeting 2024 (Accepted talk)
- Workshop Integrating synthetic biology and single molecule biophysics, 2024 (Invited Flash talk) **(best poster prize)**
- Physics of life 2023 (Poster)
- British Biophysical Society Biennial meeting (Flash talk & poster)
- Build-a-Cell Workshop, Boston (Poster, Technical Lead of working group)
- Functional DNA Nanotechnology (Poster)

Invited talks

- CalTech Synthetic Cell seminar (Invited talk).
- Imperial Biomicrofluidic Technical Seminars (Invited talk).

Teaching and Supervision.

PhD student Assistant Supervisor & Project lead **10/2022 – Current**

- Officially recognised as **Assistant Supervisor** for a PhD student in the Elani lab. Lead bi-weekly catch up meetings and attend quarterly catch up with industrial collaborators.
- Conceived **main project** idea for two further **PhD students**, one in robotic integration of microfluidics and microscopy, and the other in AI assisted Protein Network Design.

Masters project supervisor (Imperial College London) **10/2022 - Current**

- Supervised three Masters students in synthetic cell engineering, spread consistently since arriving in Imperial.

Masters project supervisor *(University of Cambridge)* **10/2021 - 06/2022**

- Created and supervised several master's student projects during the course of my PhD, including intelligent control of microfluidics using reinforcement learning and simulations of particle velocities under pressure driven microfluidic flow.
- Successfully applied for a UROP grant to support one proposed project for a summer research intern.

09/2020 – 09/2022

Awards and Achievements

- BBSRC Transformative Research Technologies Award (£250,000).
- BBS Biophysics week event award (£250) received to independently host seminar on designing artificial active transport systems.
- Poster prize (£100) from "Workshop Integrating synthetic biology and single molecule biophysics"
- Cambridge/National Physical Laboratory iCASE award
- Elected Scholar at Gonville & Caius college.