DIFFUSIOPHORESIS OF BLOOD CELLS AND VESICLES IN TRANSIENT CHEMICAL GRADIENTS

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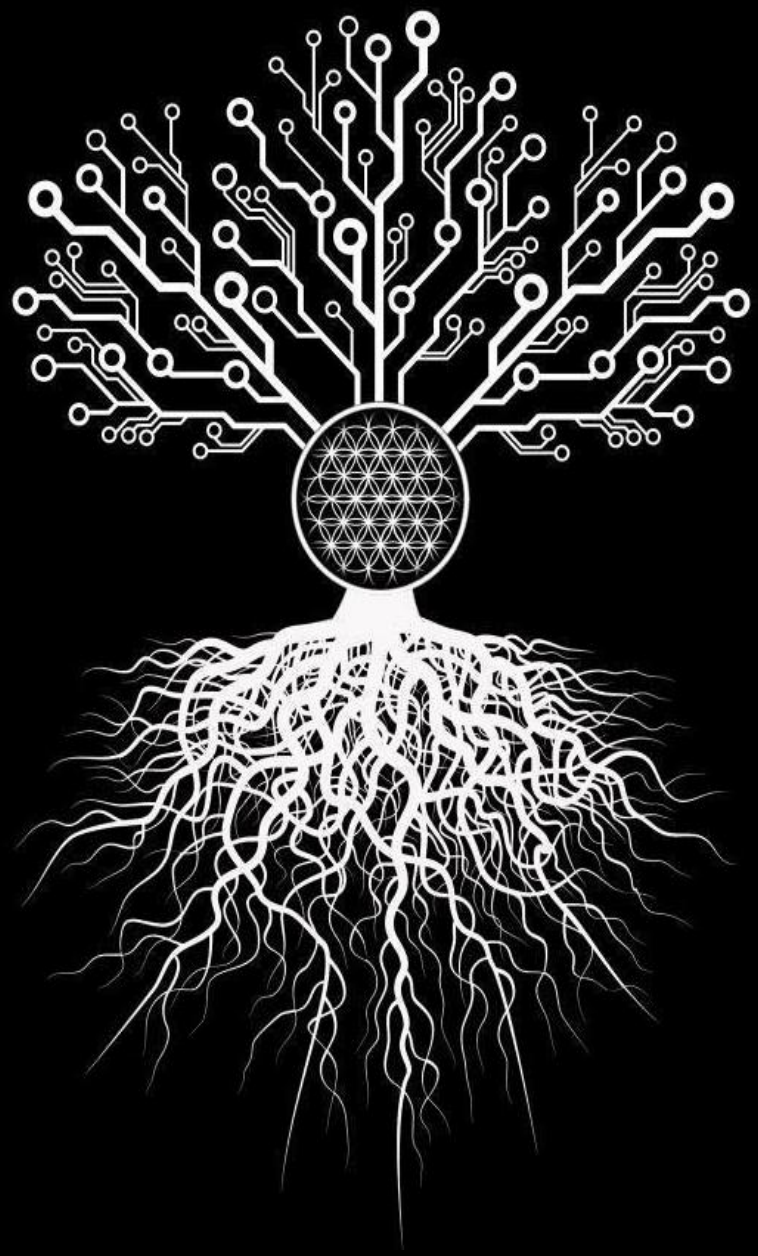
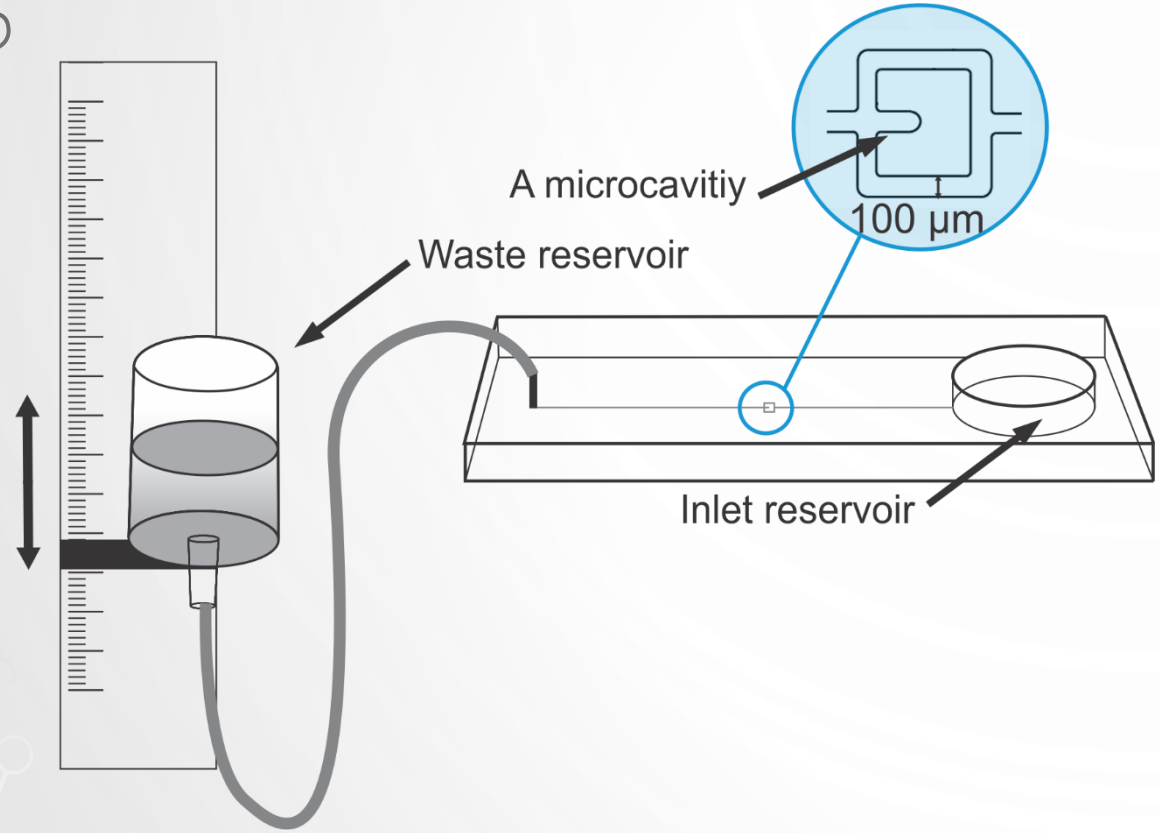
Bojan Božič and Jure Derganc

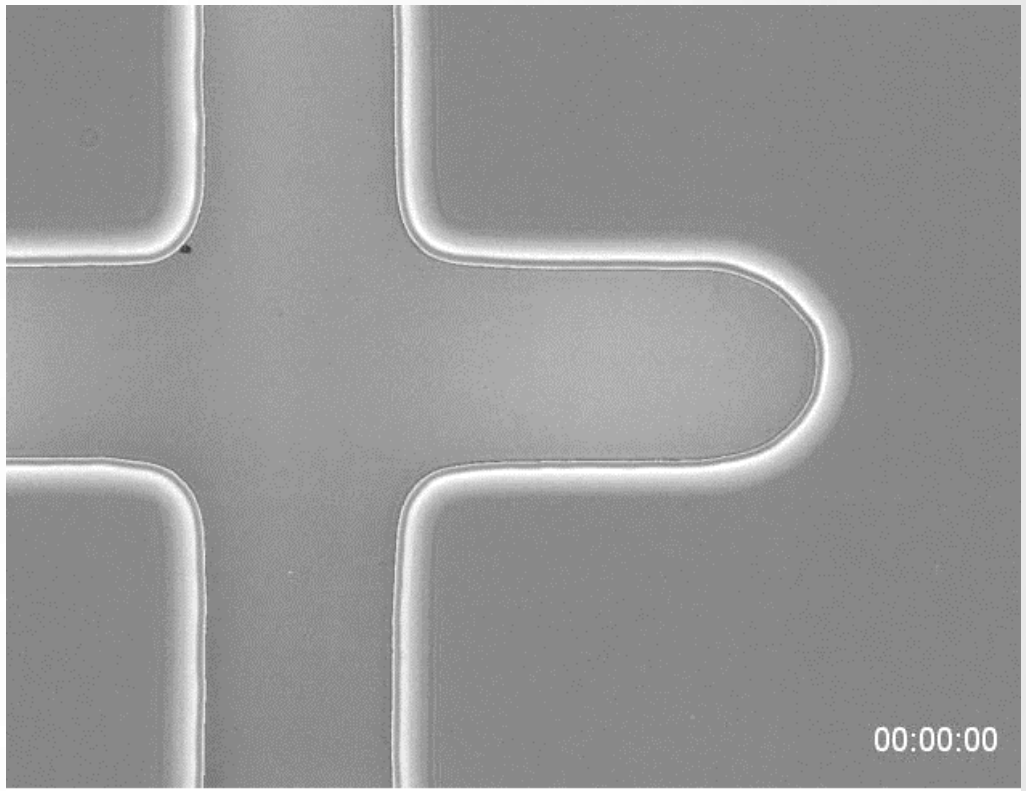


OUTLINE

- A microfluidic system with microcavities
- Migration of cells and vesicles
- Diffusiophoresis as possible explanation
- Conclusions

A MICROFLUIDIC SYSTEM WITH MICROCAVITIES

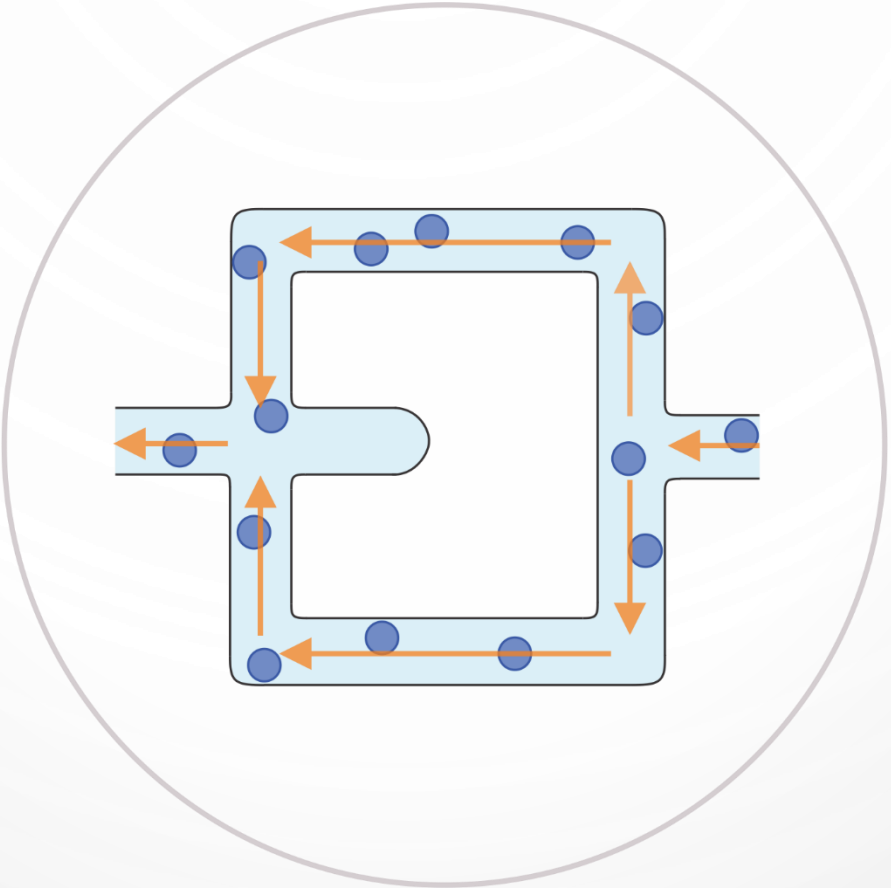




Vrhovec S., M. Mally, B. Kavčič, J. Derganc. 2011. "A microfluidic diffusion chamber for reversible environmental changes around fl
Lab Chip. 11:4200–4206.

A MICROFLUIDIC SYSTEM WITH MICROCAVITIES

Experimental setup



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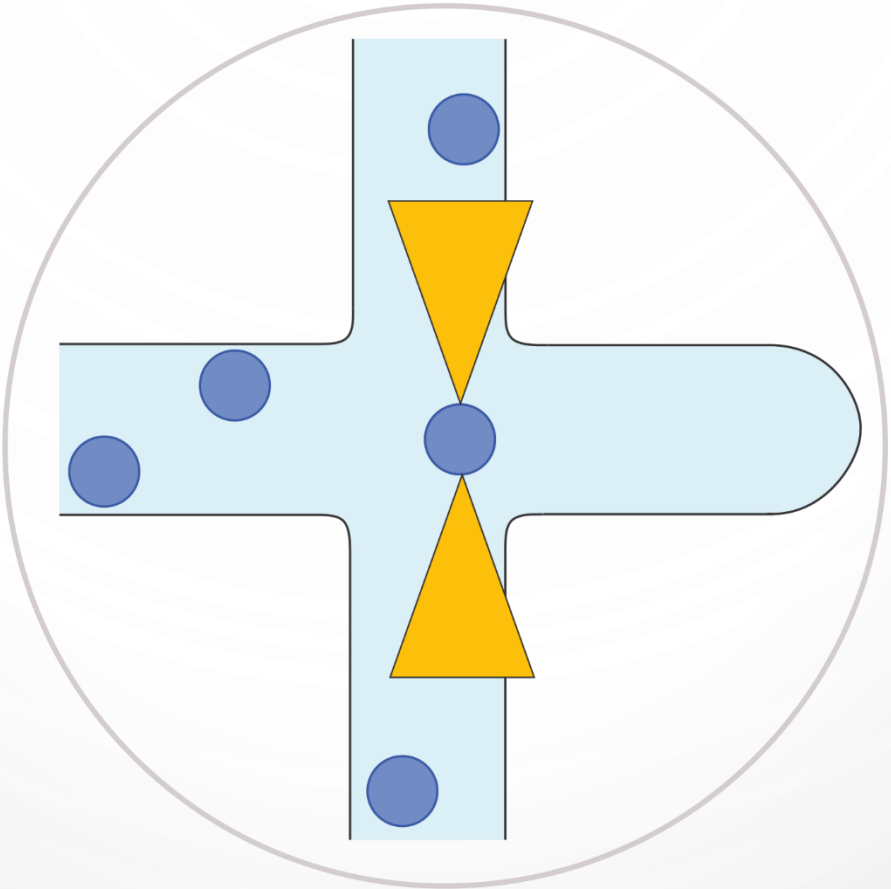

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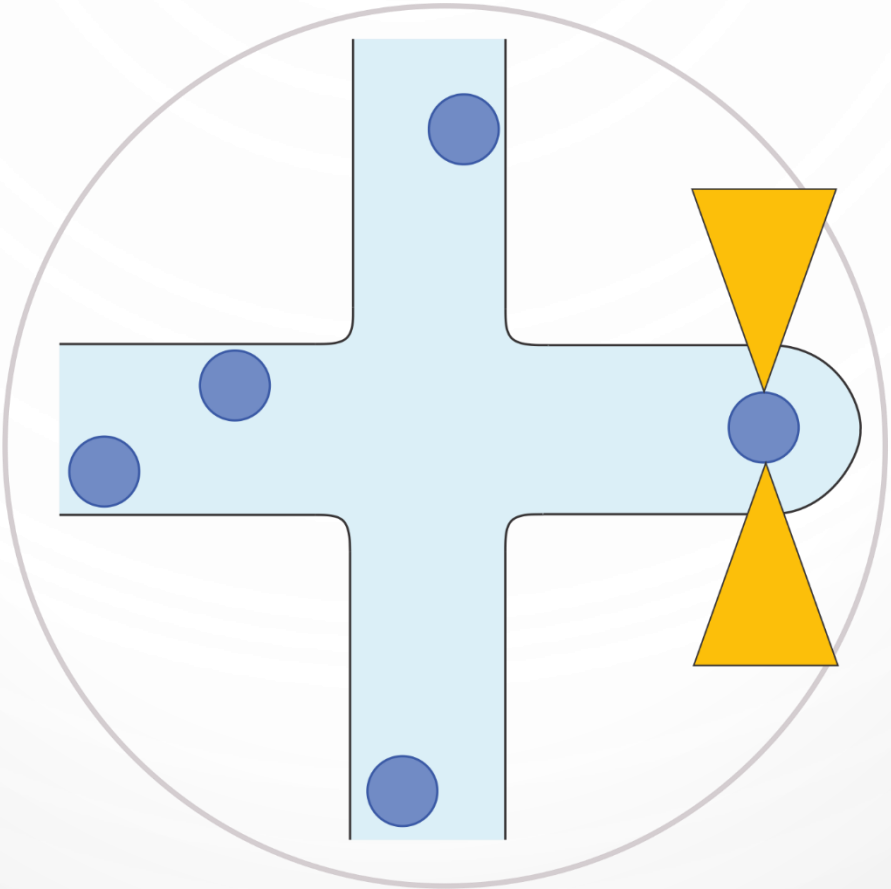

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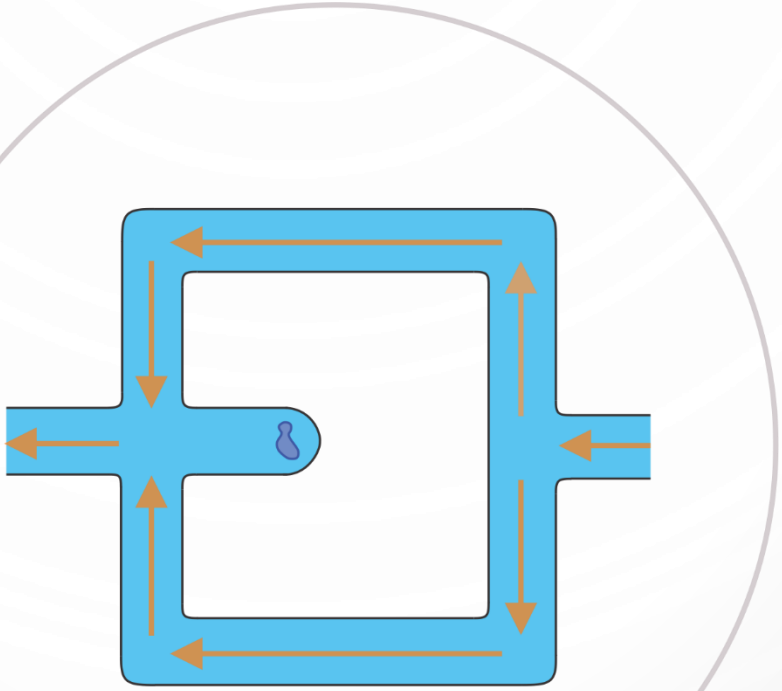
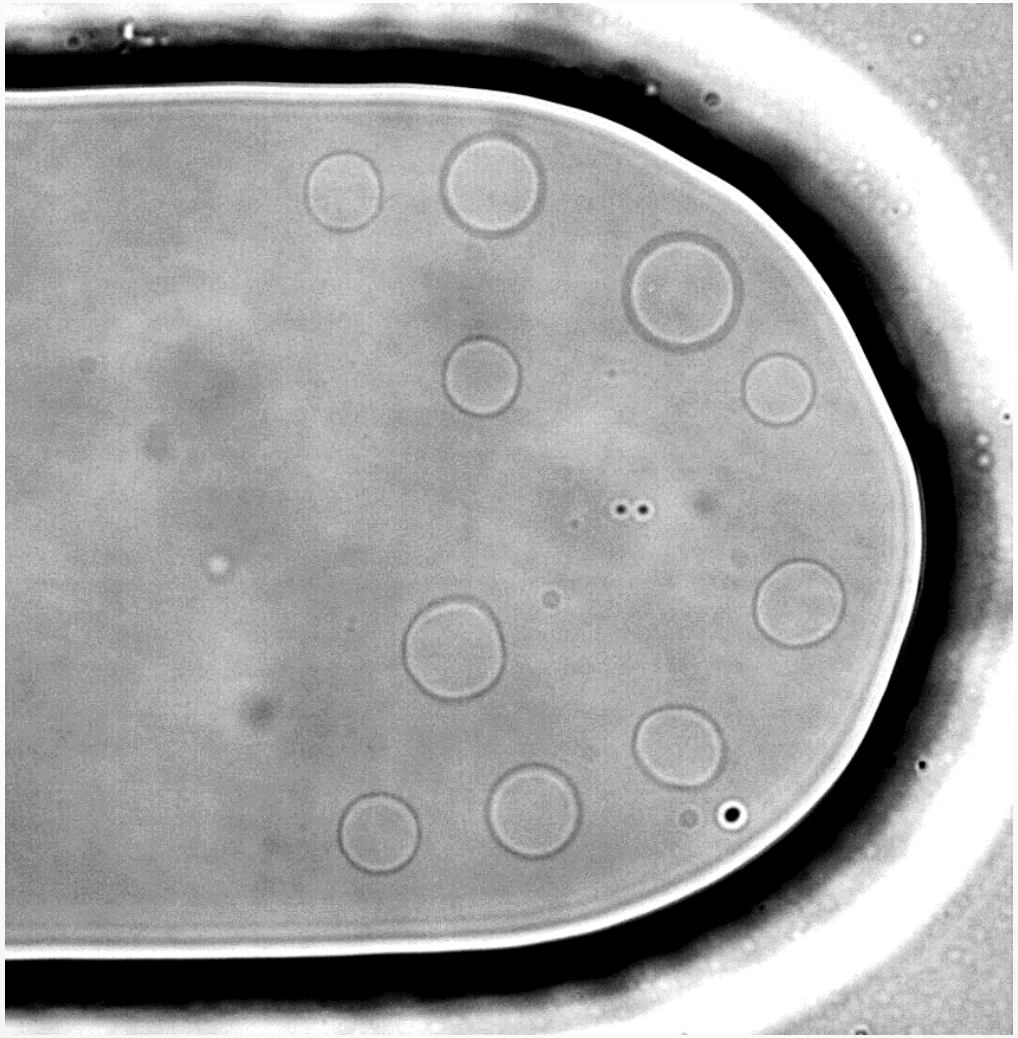


MIGRATIONS OF CELLS AND VESICLES

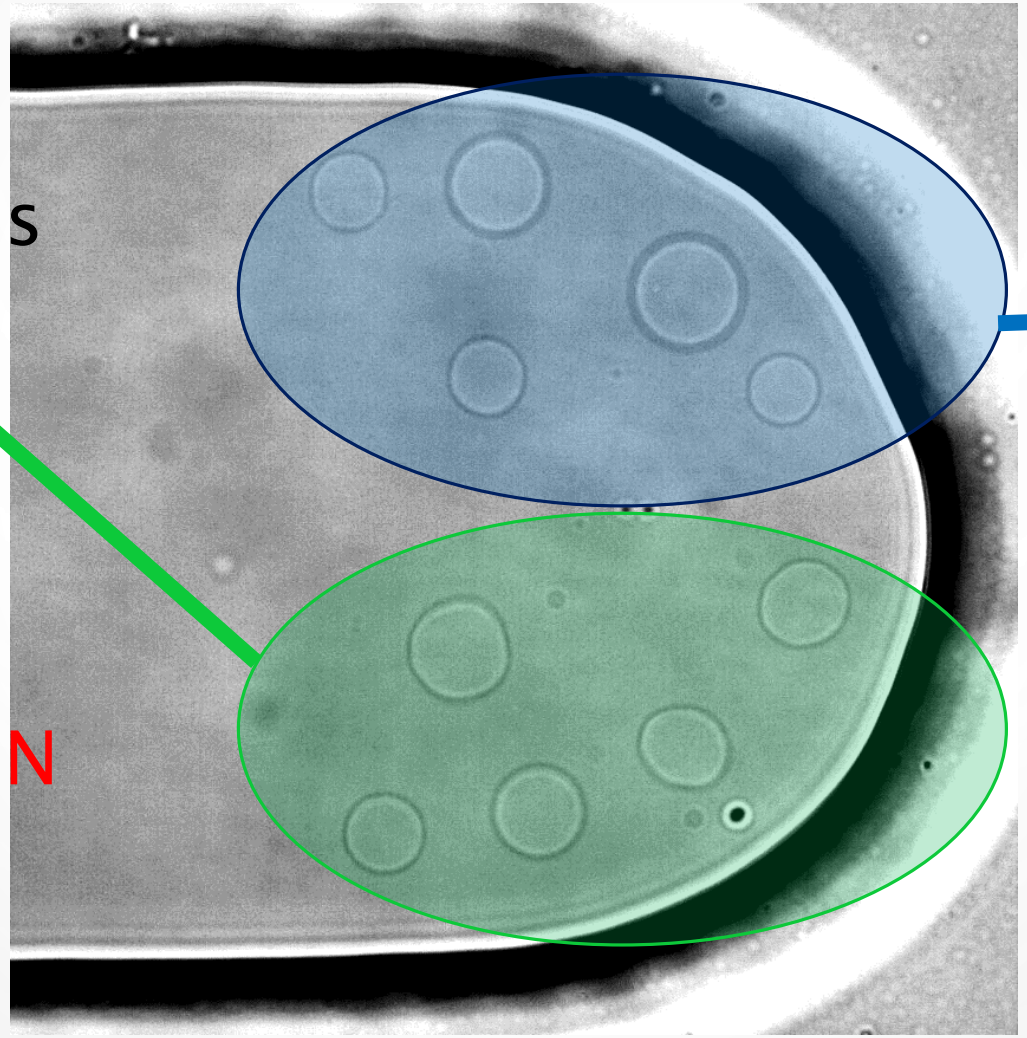


GLUCOSE SOLUTION

MIGRATIONS OF CELLS AND VESICLES

Neutral phospholipid vesicles

DOPC (100%)

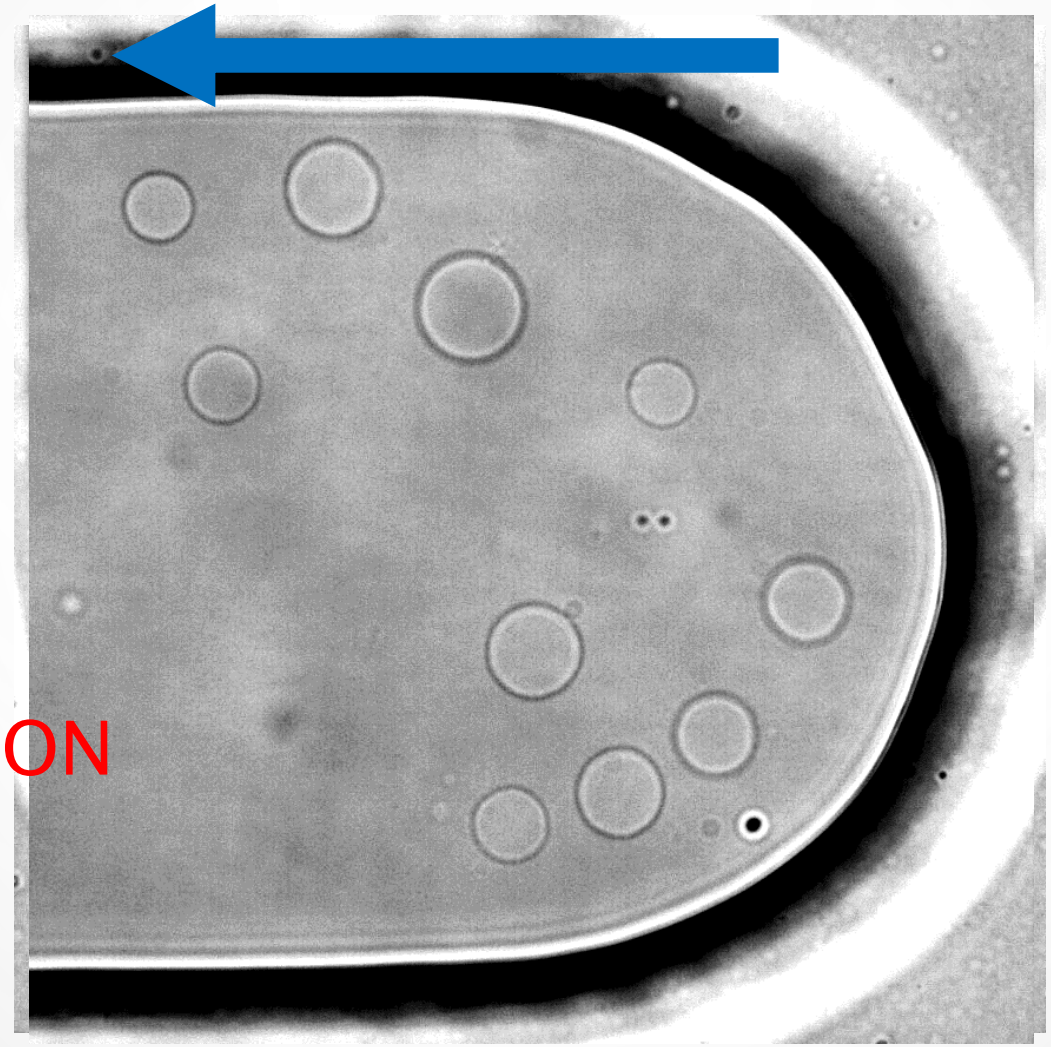


Negatively charged phospholipid vesicles

DOPC (50%)/DOPS (50%)

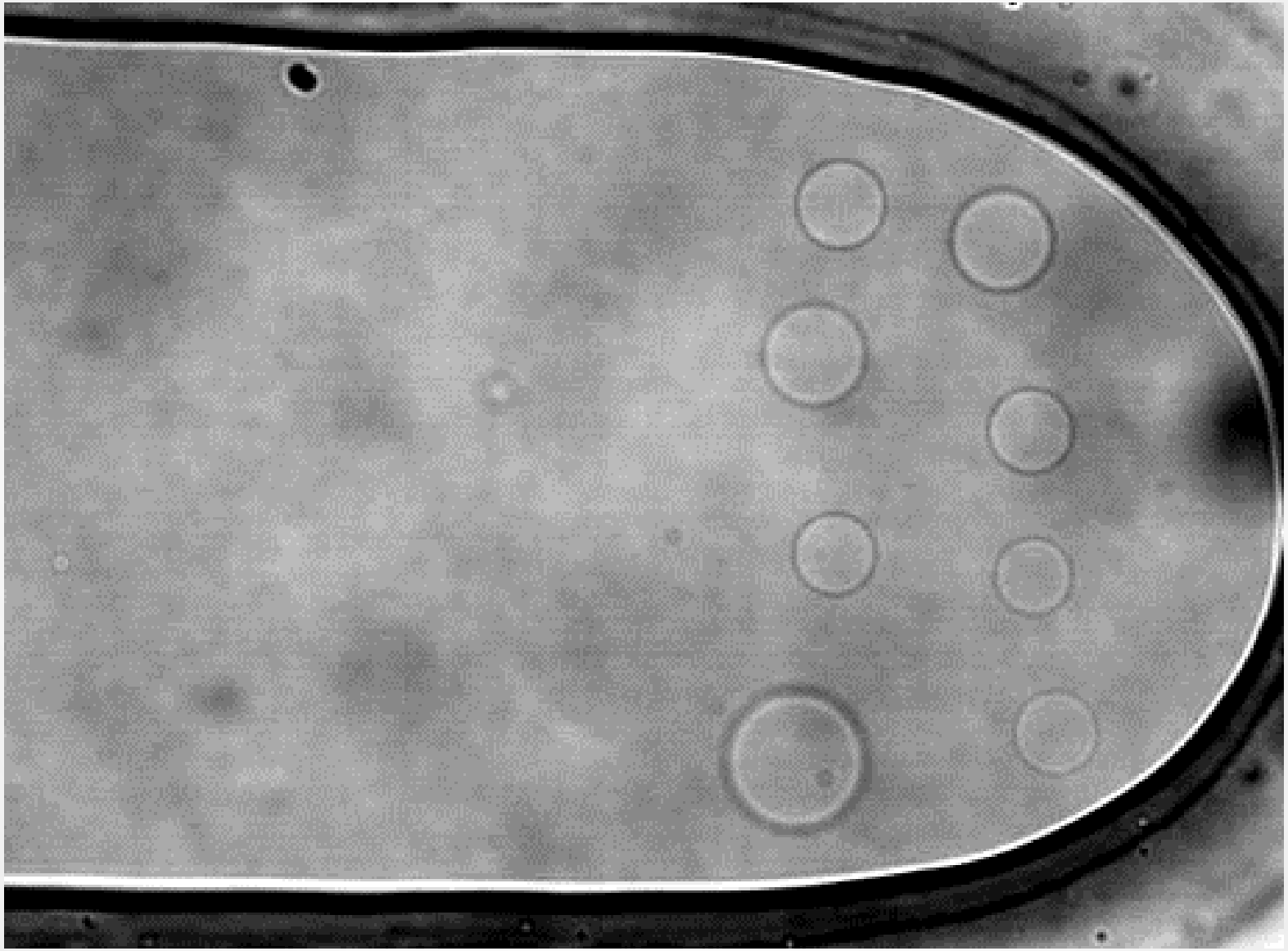
GLUCOSE SOLUTION

MIGRATIONS OF CELLS AND VESICLES



Migrations towards the microcavity entrance

PBS BUFFER SOLUTION



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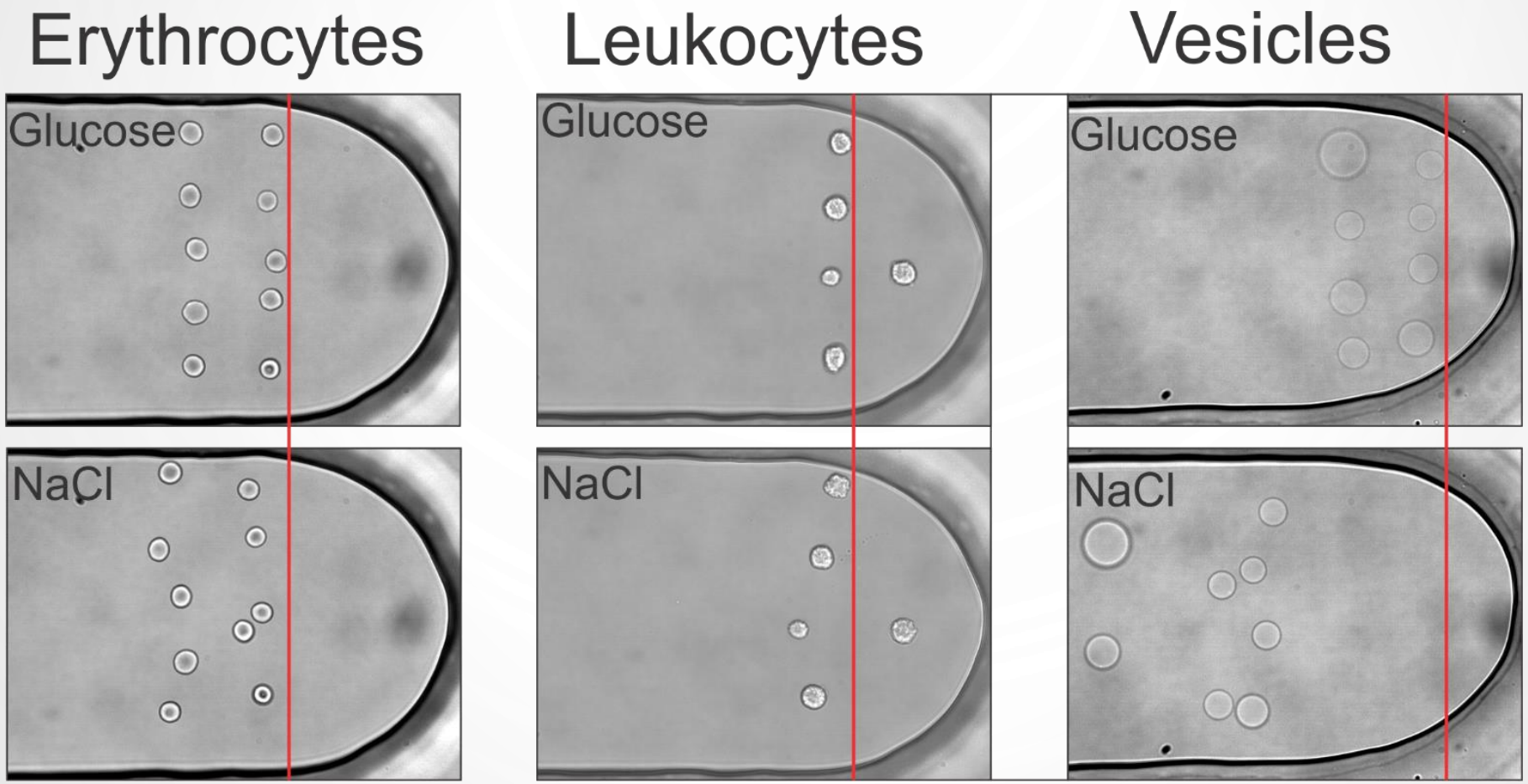


MIGRATIONS OF CELLS AND VESICLES

DIFFERENT SOLUTIONS

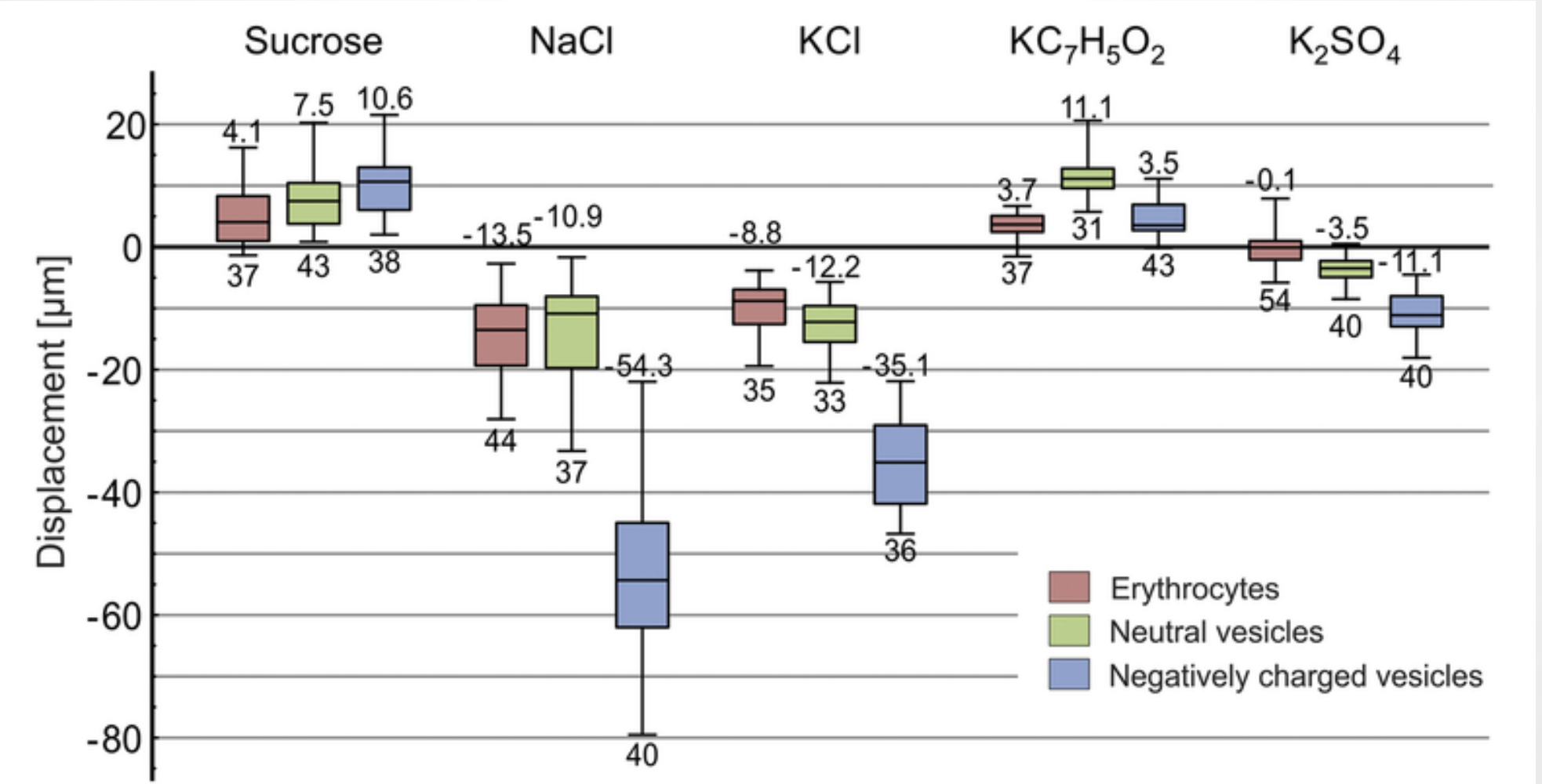
- Sucrose
- NaCl
- KCl
- $KC_7H_5O_2$
- K_2SO_4

The exchanged solutions had the same osmolarity as the initial glucose solution

DIFFUSION COEFFICIENTS OF THE SOLUTES

	Diffusivity [10^{-9} m^2/s]	
Sucrose	0.5	(Ribeiro et al. 2006)
Glucose	0.6	(Ribeiro et al. 2006)
K^+	1.957	(Velegol et al. 2016)
Na^+	1.334	(Velegol et al. 2016)
Cl^-	2.032	(Velegol et al. 2016)
SO_4^{2-}	1.065	(Velegol et al. 2016)
$C_7H_5O_2^-$	0.9	(Noulty and Leaist 1987)

MIGRATIONS OF CELLS AND VESICLES



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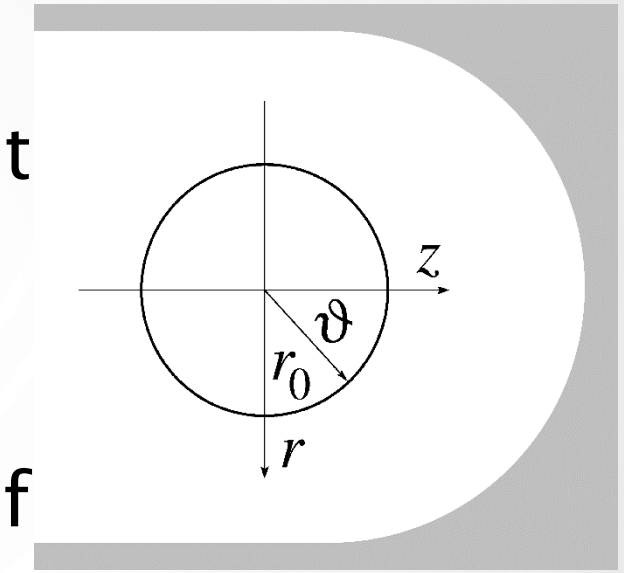
New biotechnology.

DIFFUSIOPHORESIS IN TRANSIENT CHEMICAL GRADIENTS

- Migration velocity caused by the surface t

$$v_\mathrm{s} = \frac{2r_0}{3\eta}\left[\left.\frac{\partial\gamma}{\partial c_1}\right|_{c_1,c_2=0}\frac{\mathrm{d}c_1}{\mathrm{d}z} + \left.\frac{\partial\gamma}{\partial c_2}\right|_{c_2,c_1=0}\frac{\mathrm{d}c_2}{\mathrm{d}z}\right]$$



- Migration velocity caused by the electric f

$$v_\mathrm{d} = \frac{\varepsilon\varepsilon_0}{4\pi\eta}\left(\frac{k_\mathrm{B}T}{Ze_0}\right)^2\left[\frac{D_+ - D_-}{D_+ + D_-}\frac{Ze_0\zeta}{k_\mathrm{B}T} - 2\ln\left(1-\tanh\left(\frac{Ze_0\zeta}{4k_\mathrm{B}T}\right)^2\right)\right]\frac{\mathrm{d}}{\mathrm{d}z}\ln c$$

- Migration velocity caused by the osmosis

$$v_\mathrm{o} = -\frac{1}{3}\,lN_\mathrm{A}k_\mathrm{B}Tr_0\,\frac{\mathrm{d}c}{\mathrm{d}z}$$

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CONCLUSIONS

- A diffusive exchange of solutions can cause significant passive migration of blood cells and synthetic phospholipid vesicles in microcavity.
- This phenomenon is called diffusiophoresis.
- Migrations were observed in concentration gradients of both non-electrolyte and electrolyte solutions.

ACKNOWLEDGMENTS

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THANK YOU!

Jure Derganc

Bojan Božič

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