Electronic Supplementary Material (ESI) for Lab on a Chip.

1 Supplementary Information

1.1 Discussion of the trapping power in a single curved/cornered wall in simulations

There is some apparent contrast between our results and those reported in[1]. In that work, the authors first study sperm trapping numerically in single pockets ranging from V-shaped to U-shaped (varying smoothly the curvature of the bottom of the pocket) and conclude that U-shape has a relatively smaller trapping power (consistent with our findings). However they deduce that this may increase the concentrating power of a membrane made of many such pockets, because cells would not stuck in the pockets and could smoothly fill the "in" side of the chamber, obtaining a uniform concentration of trapped sperm far from the pockets. In further numerical experiments, they verify their idea by simulating a chamber separated by a membrane made of many pockets, as in our Fig. 1a. The size and aperture of their pockets, L, grow proportionally with the curvature $L \propto R$ which is directly varied, while the gap size L_{gap} is kept constant. However such a protocol implies the variation of a parameter which influences crucially the trapping power, i.e. the ratio L/L_{gap}. It is difficult, in their experiment with $L \propto R$, to discriminate between the effect of increasing the curvature R (which, according to their same results, reduces the trapping power) and the effect of increasing the ratio L/L_{gap} (which on the contrary increases the trapping power since it increases the fraction of the membrane surface which captures sperms coming back from "in" to "out"). Here we report the results of a different experiment: we have considered two families of shapes at fixed curvature R, one family where $R \ll A < L$ (A being the oscillation amplitude) and the other where $L \sim R \gg A$. In order to verify the effect of R/L_{gap} without changing L/A we have tuned L_{gap} only. The result is shown in Fig. 1b. It is evident that a membrane made of pockets with small curvature has always a larger trapping power, for the reason we have explained in the main text, i.e. there is a self-trapping mechanism due to the tail oscillation when it is much larger than the trap curvature R. In our opinion this experiment reconciles our findings with those in[1].

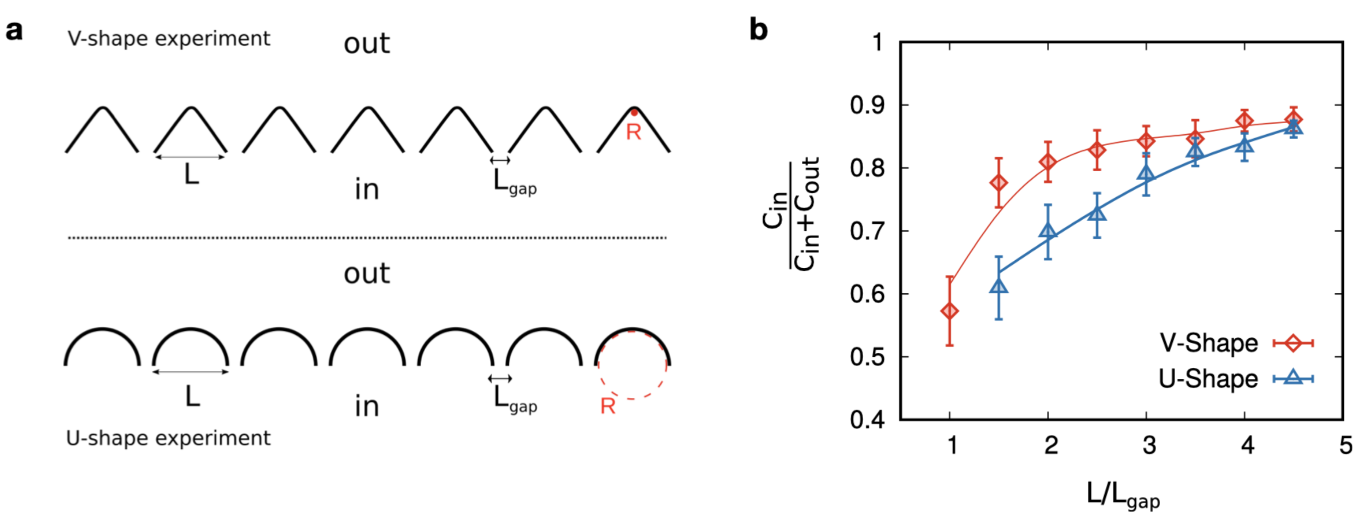

Fig. 1 **Effect of the ratio between curvature and gap size.** A numerical experiment is performed with sperms swimming in a box with periodic boundary conditions, the box cut into two halves, separated by a "membrane" (or wall) made of a sequence of 7 concave pockets, conceptually similar to the petals used in the main text. Two series of results are compared: one with "V-shaped" pockets, i.e. such that the internal curvature R is much smaller than the effective diameter (including the oscillation amplitude) of the model sperm $A+\sigma$, the other with "U-shaped" pockets (which in this case are exactly halves of circles), i.e. such that $R \gg A+\sigma$. a. Sketch of the two setups for the two compared numerical experiments, where the "out" and "in" regions are marked. b. Plot of the relative concentration of cells comparing region "in" versus region "out", as a function of the ratio L/L_{gap}, for the two different shapes of the pockets.

1.2 Explanation of supplementary movies

The movies with name "experiment_XXX.mp4" (where XXX includes a first letter B or S corresponding to big or small L_{gap}, a second number 4 or 5 corresponding to the number of petals in the structure, and the word "rounded" or "cornered" representing the kind of curvature of the petal) show the recorded dynamics from 8 experiments with the 8 different structures considered in the Main Article.

The movies with name "movieXshape_largegap.mp4" (with X being U or V corresponding to rounded or cornered petals) show some evolution from the numerical simulations with 4 petals and $L_{gap}/\sigma = 6.5$.

The movies "simulation_single_XXX.mp4" are useful to grasp immediately the trapping mechanism explained in the Main Text. The movie with "XXX=largecurvature" shows the dynamics of a single sperm with oscillating dynamics ($A > 0$) and the curvature radius R of the trap is such that $R \gg A + \sigma$, so that the sperm is able to escape the trap. The movie with "XXX=smallcurvature" shows the dynamics of a single sperm with oscillating dynamics ($A > 0$) and the curvature radius R of the trap is such that $R \ll A + \sigma$, so that the sperm is able to escape the trap. The movie with "XXX=smallcurvature_nooscillation" shows the dynamics of a single sperm without oscillating dynamics ($A = 0$), so that the sperm is able to escape the trap even if the curvature is quite small.

Notes and references

1 A. Guidobaldi, Y. Jeyaram, I. Berdakin, V. V. Moshchalkov, C. A. Condat, V. I. Marconi, L. Giojalas and A. V. Silhanek, *Phys. Rev. E*, 2014, **89**, 032720.