Supplementary Information (SI) for RSC Advances.
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**Optimisation of design parameters and drug concentration gradient generation in the µCGG Platform using COMSOL simulations.**

The proposed µCGG design, as well as the precise microchannel arrangement, was at first assessed through *in silico* studies using COMSOL Multiphysics software (v5.3) to evaluate the effectiveness of the design parameters in generating chemical gradients and to optimize the system prior to fabrication. A 2D representation of the on-chip platform was created using the software's geometry module (Fig. S1). Numerical simulations were then performed in 2D (to save computational time and memory) to simulate the chemical concentration gradient profile inside the µCGG platform, using a discretization approach based on the finite elements method. The simulations were performed for up to 48 hours, utilizing the default time-dependent solution method, which employs a backward differentiation formula time marching, and were run until full convergence was achieved. Meshing was done by generating a free tetrahedral mesh controlled by laminar flow physics.

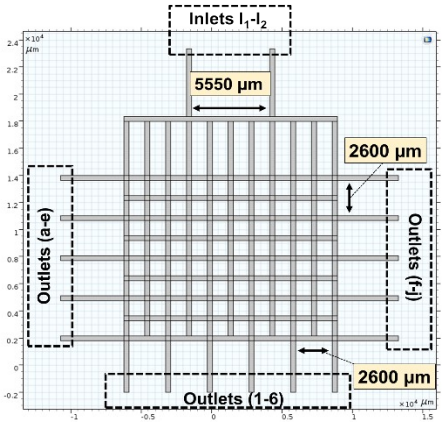


**Figure S1:** 2D schematic representation of the initial µCGG design used in simulations, highlighting the spacing between the outlets.

The transport of drug molecules and generation of concentration gradient was computationally estimated throughout the device geometry, using the "transport of diluted species" physics module. To estimate the concentration profile of the drug molecule, 5-Fu was selected as the model drug, and the simulations were conducted at different flow rates ($I_1$=$I_2$=10 µL/min; case b: $I_1$=20 µL/min, $I_2$=10 µL/min; case c: $I_1$=10 µL/min, $I_2$=20 µL/min; case d: $I_1$=50 µL/min, $I_2$=50 µL/min; case e: $I_1$=100 µL/min, $I_2$=100 µL/min). For all the cases, the concentration of 5-Fu at $I_1$ was chosen as 100 µM, and at $I_2$, it was kept at 0 µM. The diffusion coefficient (D) of 5-Fu was calculated using the expression: $D = 0.0001778 \times (\text{molecular weight})^{-0.75}$ (Swabb et al., 1974). The coefficient and parametric values used in the simulation studies are tabulated in Table S1.

**Table S1. The coefficient and parametric values used in the simulation studies**

| Parameters | Applied/ Values used | References |
|---|---|---|
| Physics type | Laminar flow<br>Transport of diluted species | - |
| Media (Water) | Density: 1000 kg/m$^3$<br>Viscosity: 0.001 Pa.s | (Yadav et al., 2022) |
| Boundary condition | No slip | - |
| 5-Fu concentration at inlets ($I_1$ and $I_2$) | $I_1$: 100 µm<br>$I_2$: 0 µm | - |
| Outlet condition | Zero pressure<br>Suppressed backflow | - |

**Mechanical characterization of PDMS using AFM**

The stiffness or elasticity of the device prepared using 20:1 prepolymer-to-crosslinker ratio of PDMS was characterized using an OXFORD Asylum 3D Infinity atomic force microscope (AFM) operating in contact mode to record force–indentation curves (Lincon et al., 2025) (Zhang et al., 2016). The measurements were conducted using a silicon nitride ($Si_3N_4$) cantilever tip of cone geometry with a half-angle of 36° and a tip radius of 10 nm. Scanning was performed over an area of 33 $\mu m^2$ at a rate of 0.75 Hz. The cantilever had a spring constant of 743.37 mN/m, and the instrument's deflection sensitivity was calibrated to 1.58 µm/V. Force–indentation data were obtained from the approach and retraction cycle of the cantilever. Mechanical parameters such as elastic modulus and stiffness were extracted from the force curves using the Hertzian contact model (Fig. S1), which relies on the curve's slope based on the following equations:-

$$F = \frac{2}{\pi}\frac{E}{1-\nu^2}(\tan\theta)\,\delta^2 \qquad \text{.....1}$$

Area of contact ($A_c$) = $4^{\tan\theta)\,d^2}$ ..... 2

$$Stiffness\ (S) = 2E\sqrt{\frac{A_c}{\pi}} \qquad \text{..... 3}$$

where F is the measured force, E stands for the elastic modulus, $\nu$ is the poison's ratio, $\theta$ is the half angle of the cantilever tip, $\delta$ is the displacement of cantilever tip, d stands for the indent depth (i.e. depression formed along the sample surface due to cantilever contact).

The stiffness was estimated using equation 3 and was found to be 9 ± 0.5 kPa.

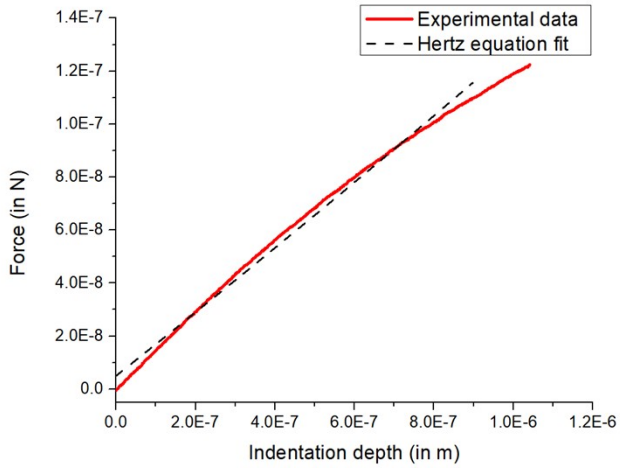


**Figure S2:** Force-indentation curve used to determine the elastic modulus (*E*) of the sample from the initial indentation by fitting using the Hertz equation.