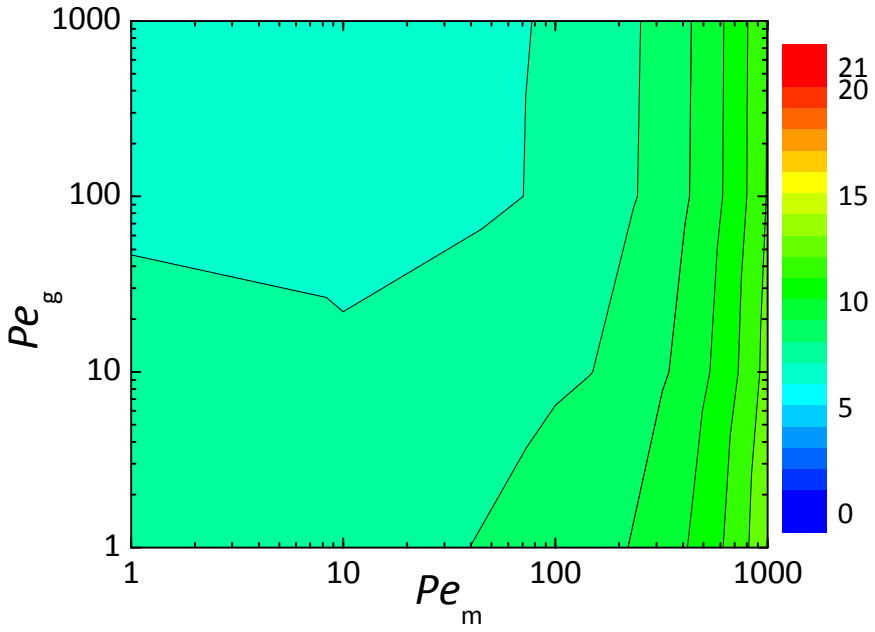



**Figure S1.** Contour map of oxygen tension at the center of the gel region on a glass cover slip, ($x$, $y$, $z$) = (0 m, $1.975\times10^{-3}$ m, $1\times10^{-6}$ m), in the microfluidic device without a film with a combination of Péclet numbers for media and gas flow, supplying 0% oxygen gas to both gas channels.

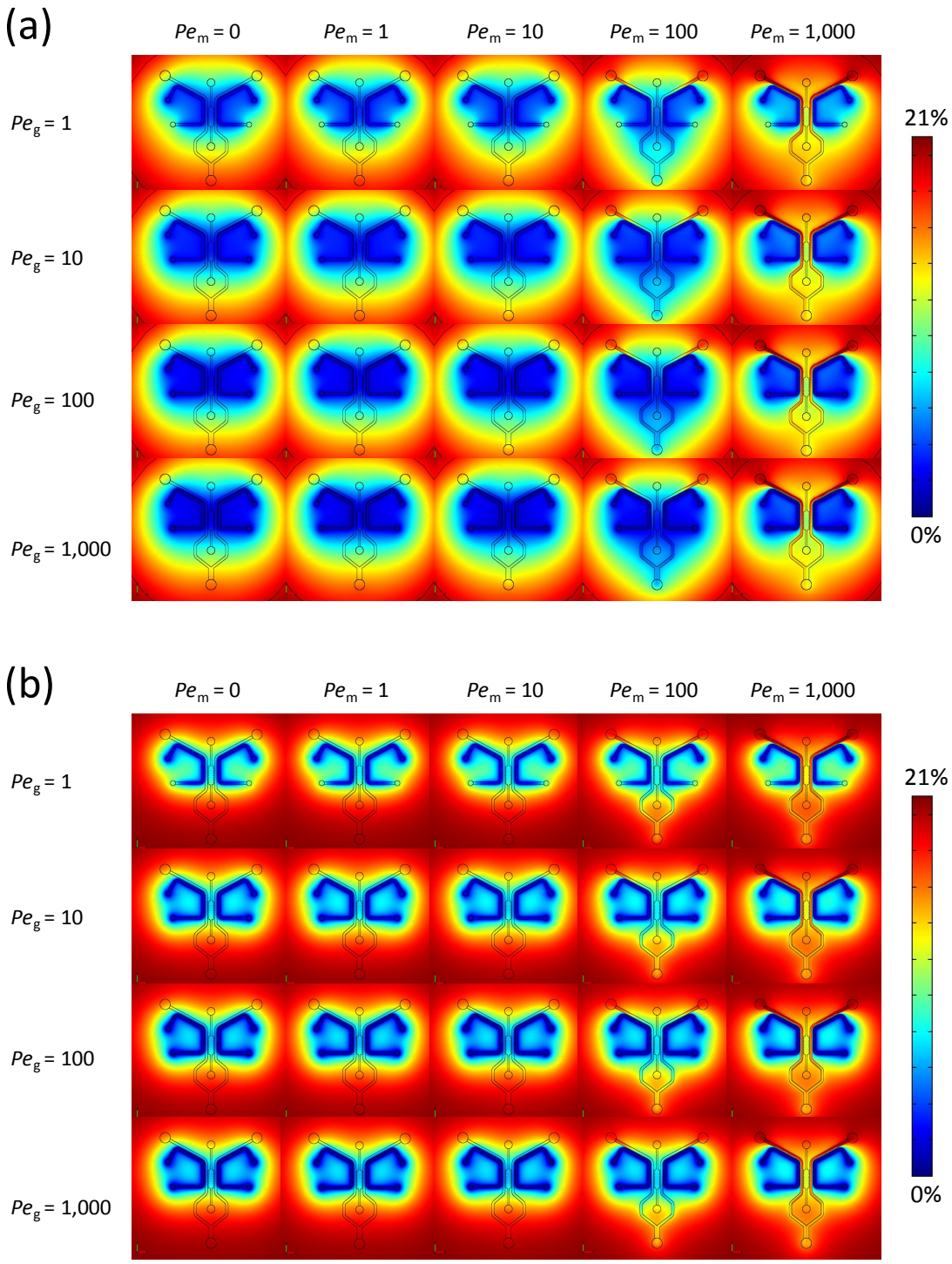



**Figure S2.** Variations of steady oxygen tension on a crosssection ($z$ = $1.0\times10^{-6}$ m) of the microfluidic devices (a) with and (b) without a film of low diffusion coefficient of oxygen ($D_{film}$ = $2.0\times10^{-12}$ $m^2/s$) with a combination of Péclet numbers for media and gas flow, supplying 0% oxygen gas to both gas channels.

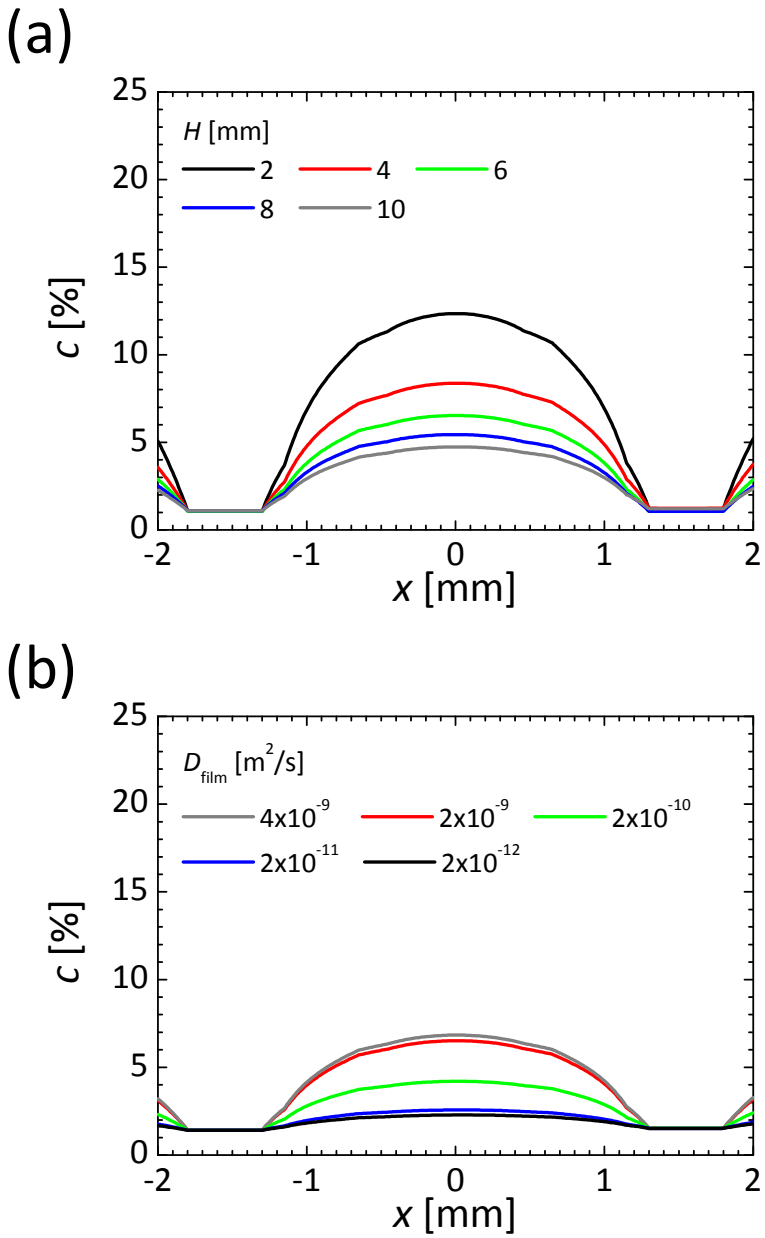



**Figure S3.** Variations of oxygen tension profile across the middle of the gel region, ($y$, $z$) = ($1.975\times10^{-3}$ m, $1\times10^{-6}$ m), in the microfluidic device at media and gas flow rates of ($Pe_m$, $Pe_g$) = (10, 100) with parameters: (a) the device of different thickness without a film, and (b) the device with a film of different diffusion coefficient of oxygen ($H$ = 6 mm).

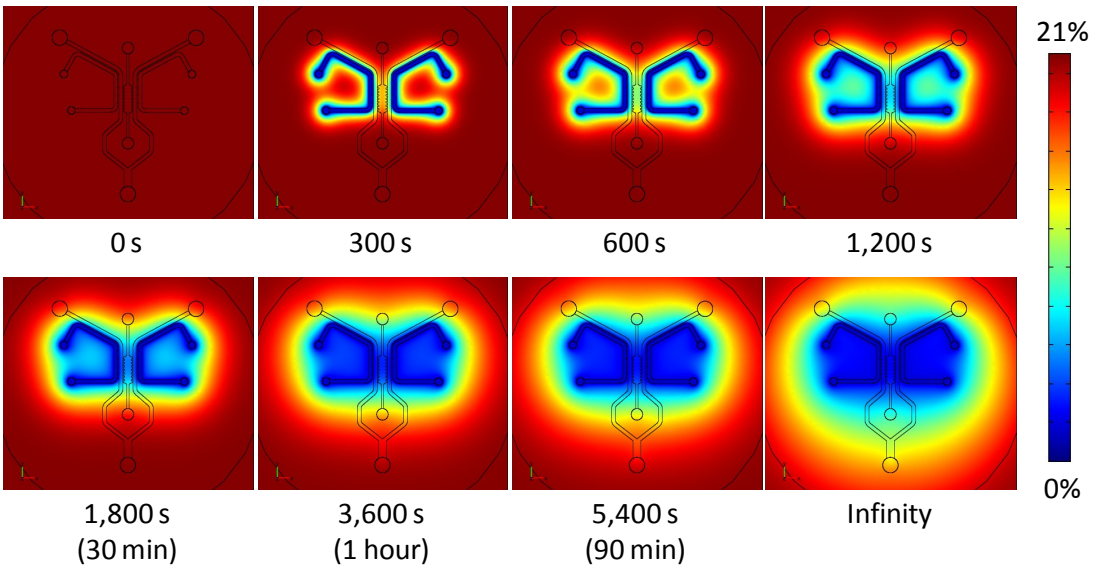



**Figure S4.** Transient change of oxygen tension on a crosssection ($z = 1.0\times10^{-6}$ m) of the microfluidic device with a film of low diffusion coefficient ($D_{film} = 2.0\times10^{-12}$ m$^2$/s), supplying 0% oxygen gas to both gas channels.

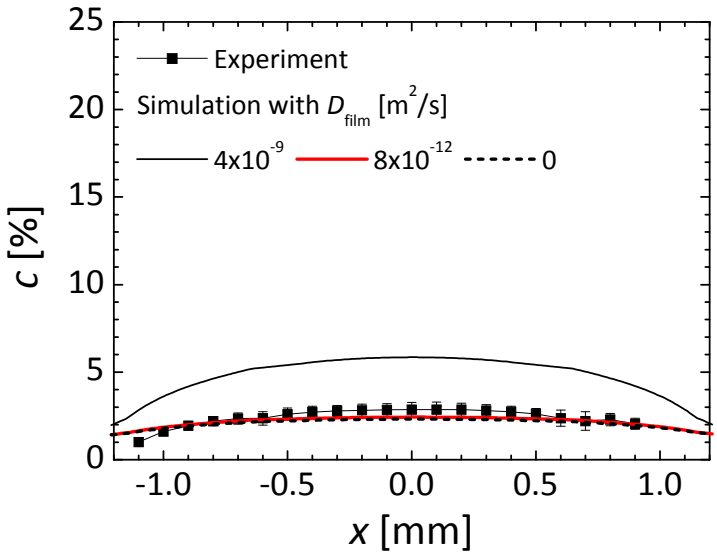



**Figure S5.** Comparison of steady oxygen tension profiles across the gel region between the experiment and the corresponding numerical simulations with three different diffusion coefficients of oxygen in a film, supplying 0% oxygen gas to both gas channels. The three different values of $D_{film}$ = 4.0×10$^{-9}$ m$^2$/s, 8.0×10$^{-12}$ m$^2$/s, and 0 m$^2$/s correspond to the microfluidic device with no film, with a PC film having the literature value of the diffusivity, or with a film having no diffusivity of oxygen, respectively.

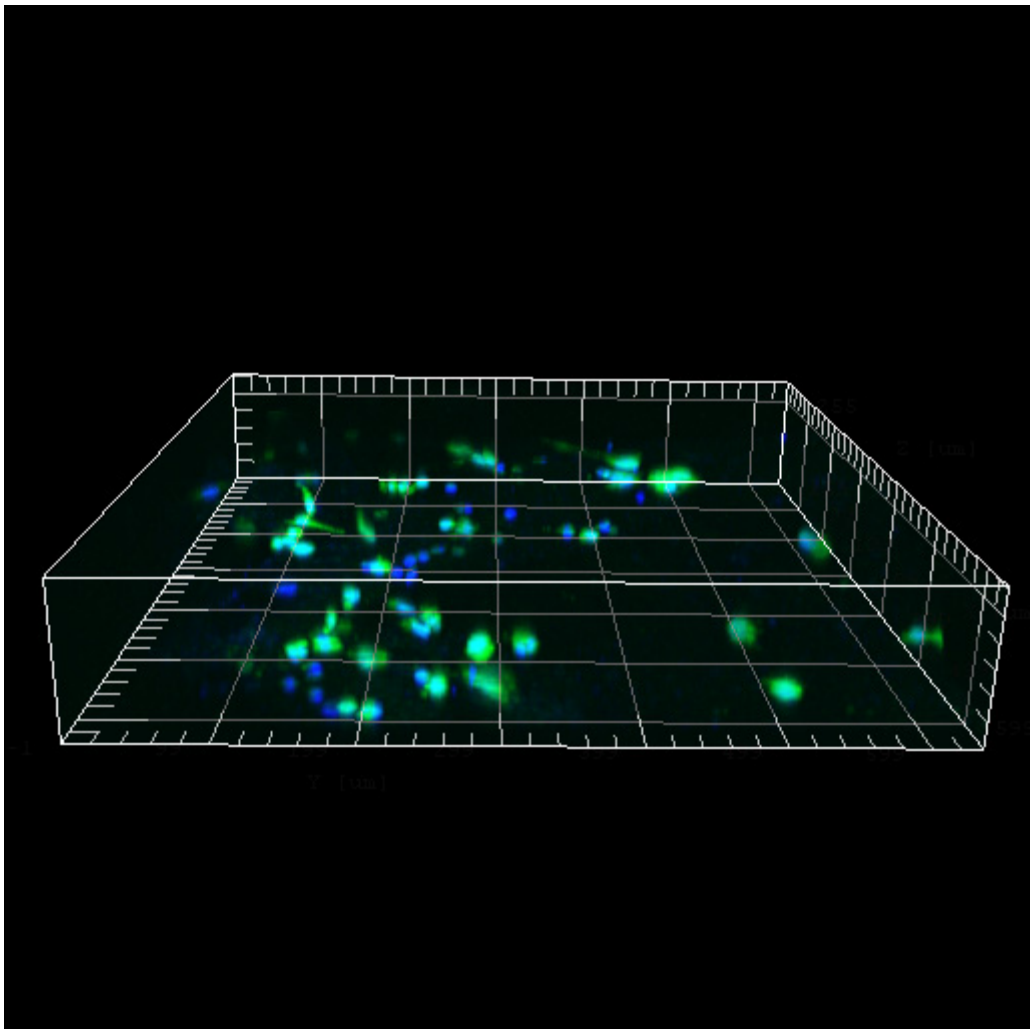


**Figure S6.** 3D confocal rendering of cancer cell distribution in the device. Tumor cells express GFP (green) and are stained for nucleus (blue: DAPI).

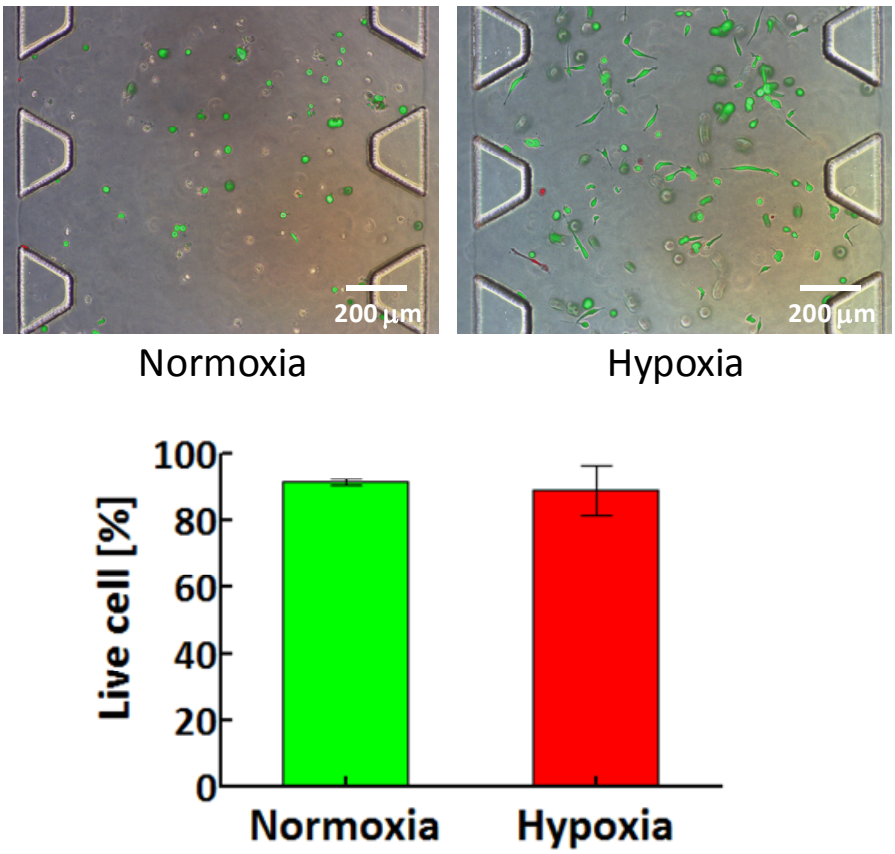



**Figure S7.** Live/dead assay of the cancer cells in the microfluidic device after >8-hr normoxia/hypoxia. Average values of four devices in each condition, and error-bars represent standard error of the mean.

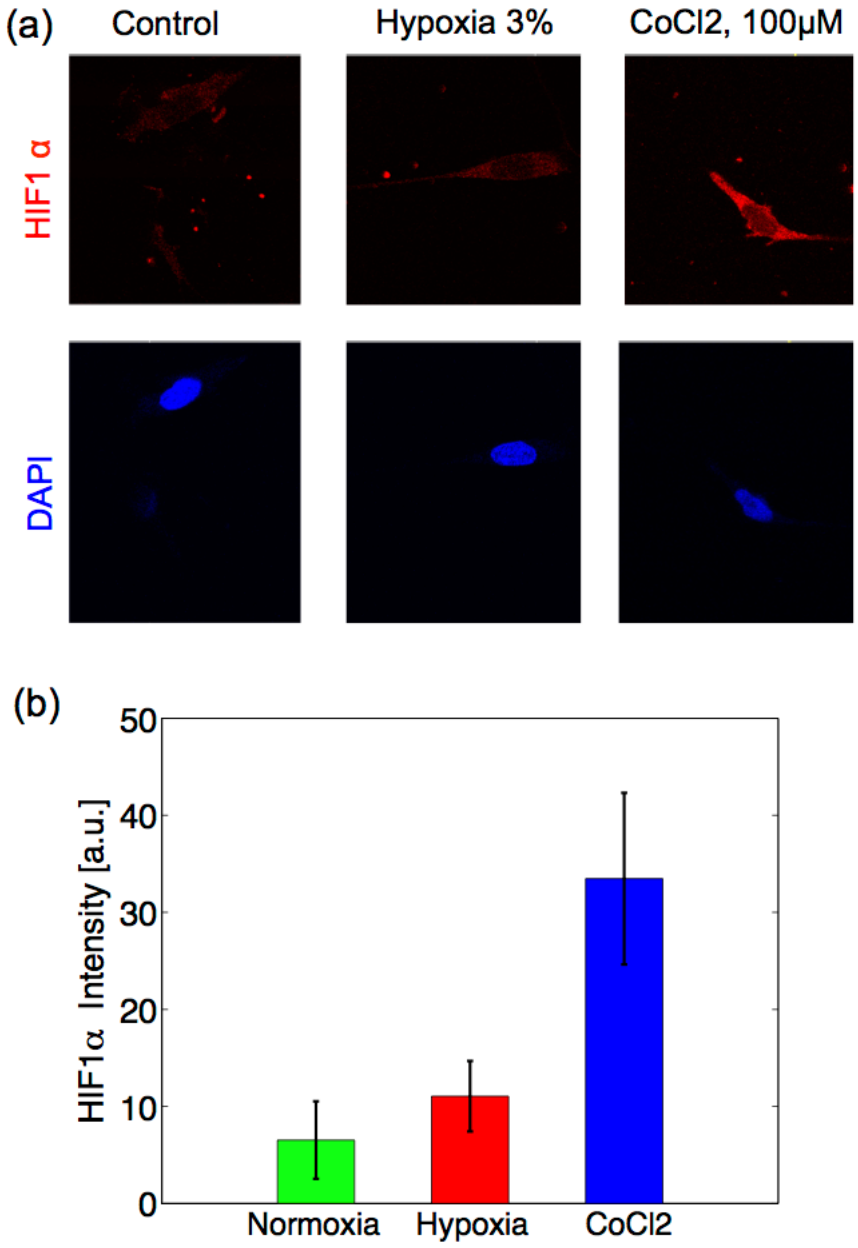
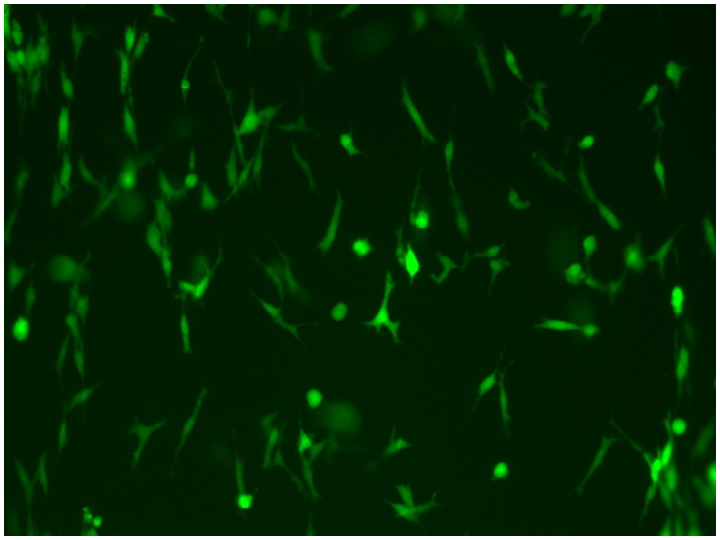


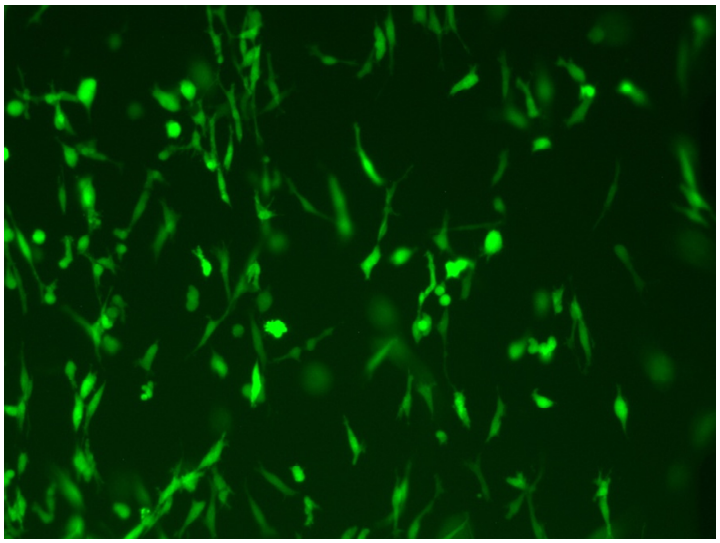

**Figure S8.** Characterization of HIF-1α in the microfluidic device: (a) Top row: Staining against HIF-1α under control (normoxia), hypoxia and stimulation with CoCl2; Bottom row: DAPI staining to indicate nucleus localization. (b) Quantification of images in (a), error-bars represent standard deviation.

Electronic Supplementary Material (ESI) for Lab on a Chip


(a)



(b)



**Movie S1.** The time-lapse images of migration of the MDA-MB-231 breast cancer cells for six hrs under (a) normoxia and (b) hypoxia.