

## Supporting Information

# Light activated nanocomposite thin sheet for high throughput contactless biomolecular delivery into hard-to-transfect cells

Hima Harshan Padma <sup>a</sup>, Donia Dominic<sup>a</sup>, Kavitha Illath, Srabani Kar <sup>b</sup>, Tuhin Subhra Santra <sup>a\*</sup>

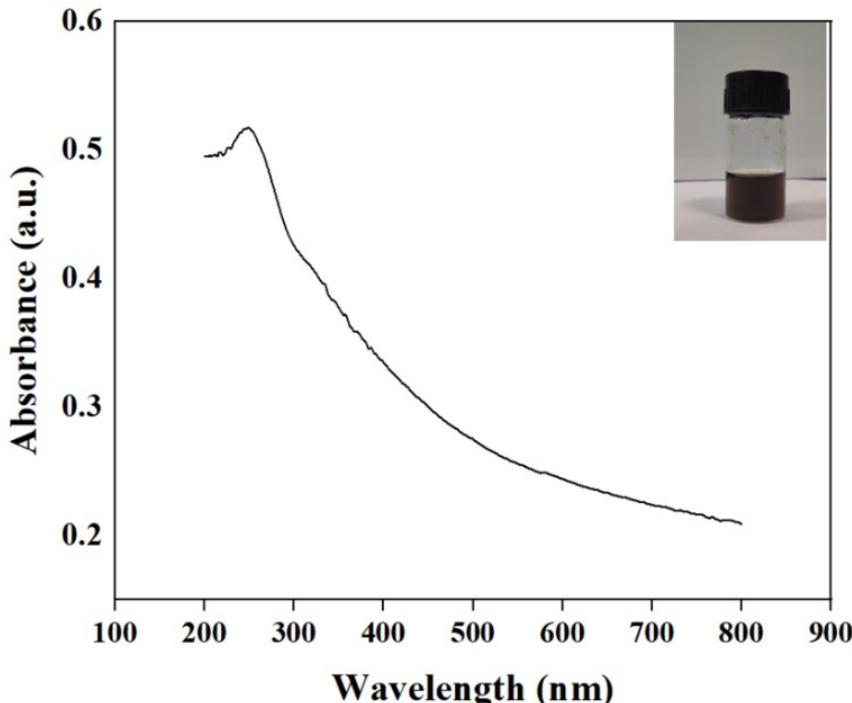
<sup>a</sup> Department of Engineering Design, Indian Institute of Technology Madras, India

<sup>b</sup> Department of Physics, Indian Institute of Technology Hyderabad, India

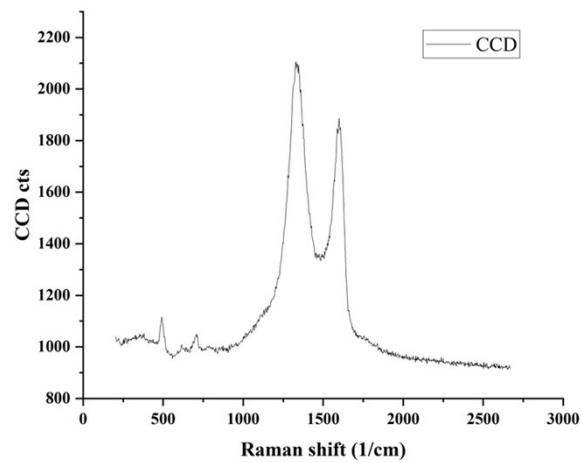
[\\*tuhin@iitm.ac.in](mailto:tuhin@iitm.ac.in) & [santra.tuhin@gmail.com](mailto:santra.tuhin@gmail.com)

### Note added after first publication

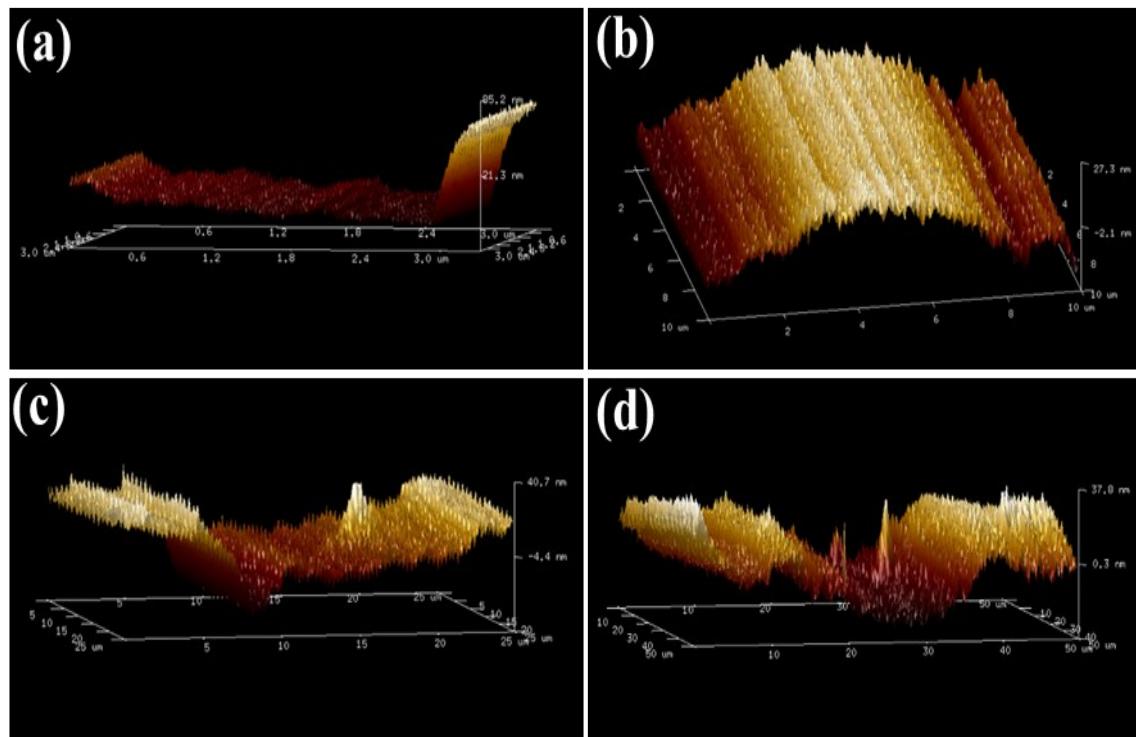
This Supplementary Information replaces the original version published on 18th December 2024.



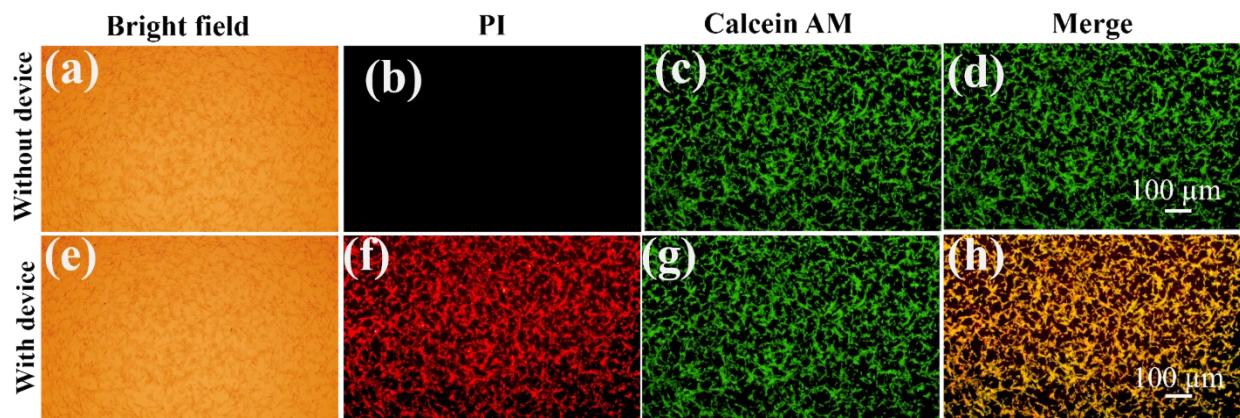
**Fig S1:** UV-Vis absorbance of rGO nanoflake



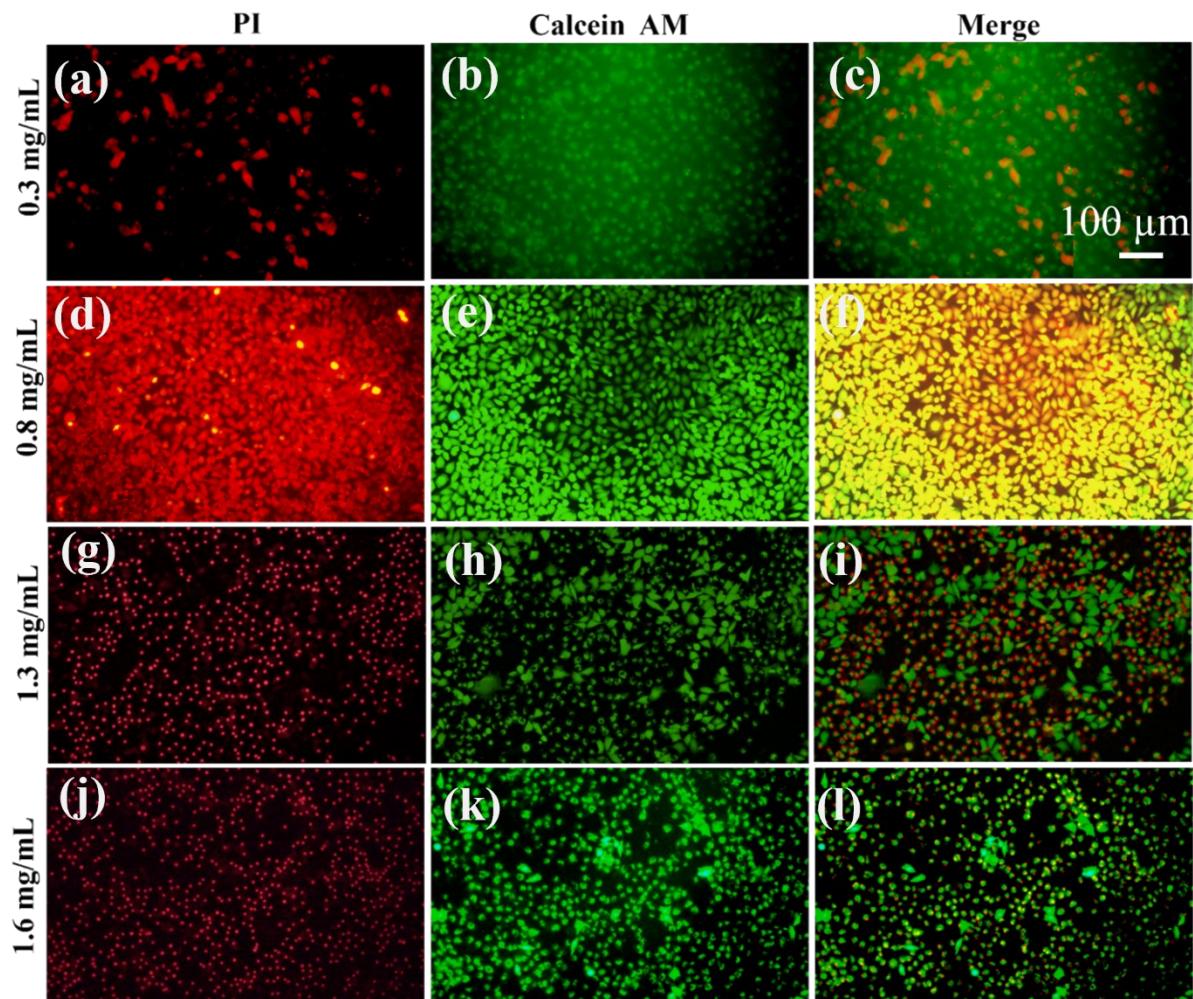
**Fig S2:** Micro Raman Spectra for rGO mixed PDMS thin sheet device



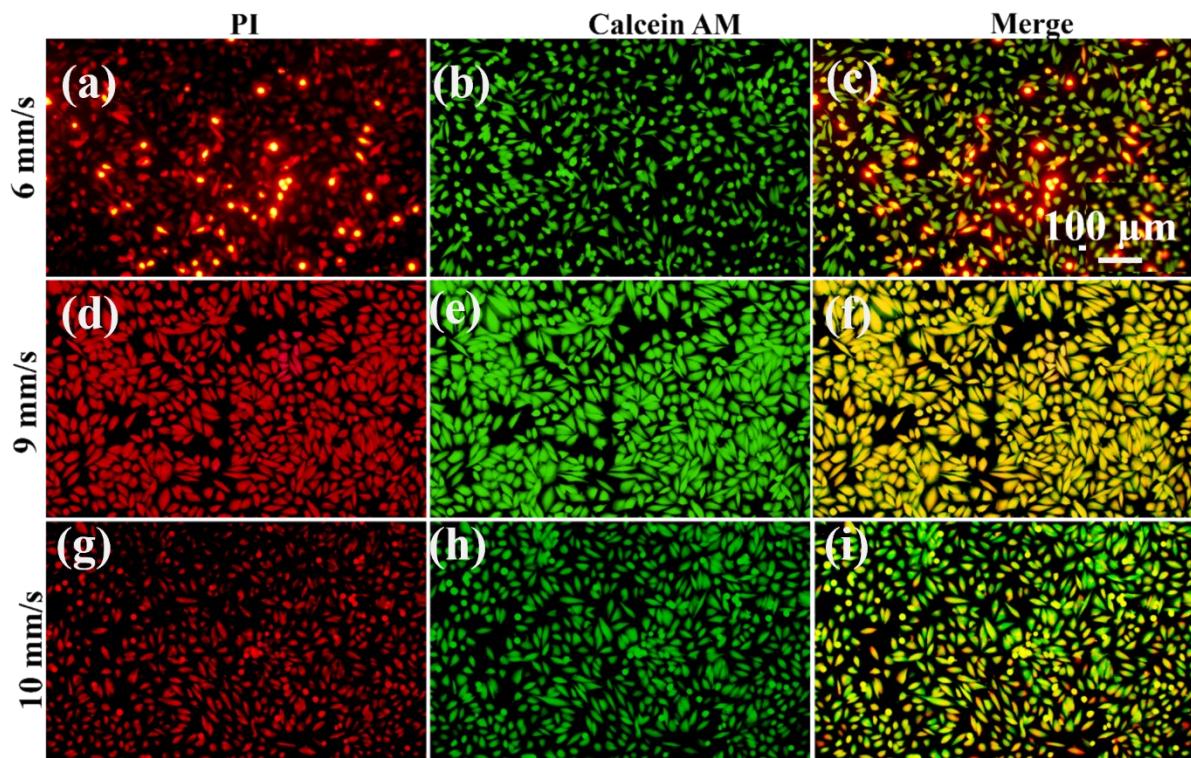
**Fig S3:** AFM image and histogram at a surface area of (a)  $3 \mu\text{m}^2$  (b)  $10 \mu\text{m}^2$  (c)  $25 \mu\text{m}^2$  (d)  $50 \mu\text{m}^2$



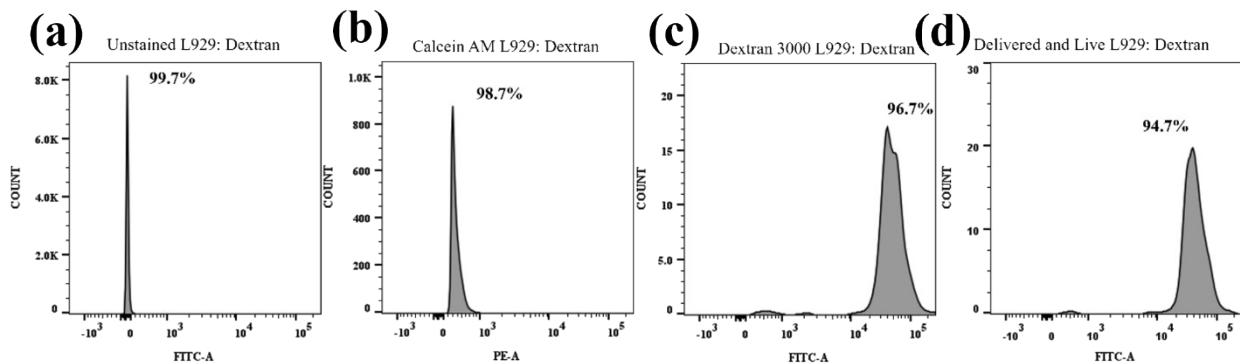
**Fig S4:** Control experiment using PI dye delivery NIH3T3 cells. Images captured after performing photoporation without rGO mixed PDMS sheet device (a-d) and with device(e-f).



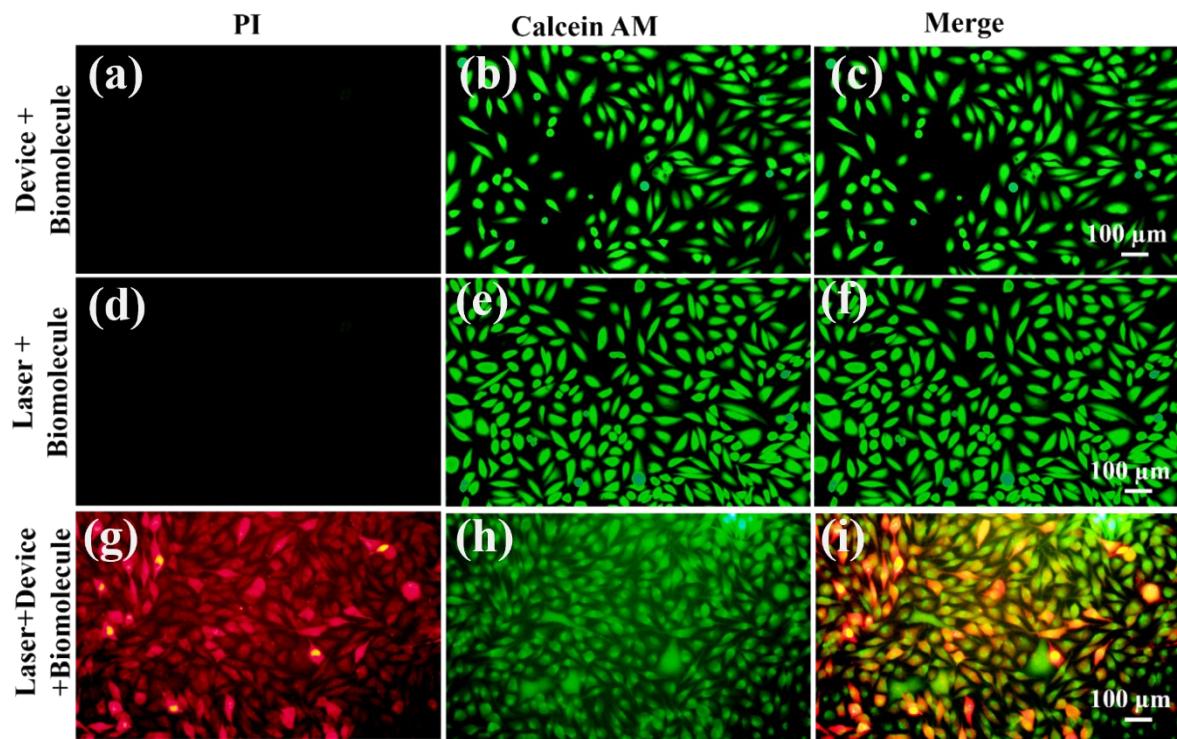
**Fig S5:** rGO concentration optimization studies on L929 cells. Images captured after performing photoporation with different concentrations (0.3 mg/mL, 0.8 mg/mL, 1.3 mg/mL, 1.6 mg/mL).



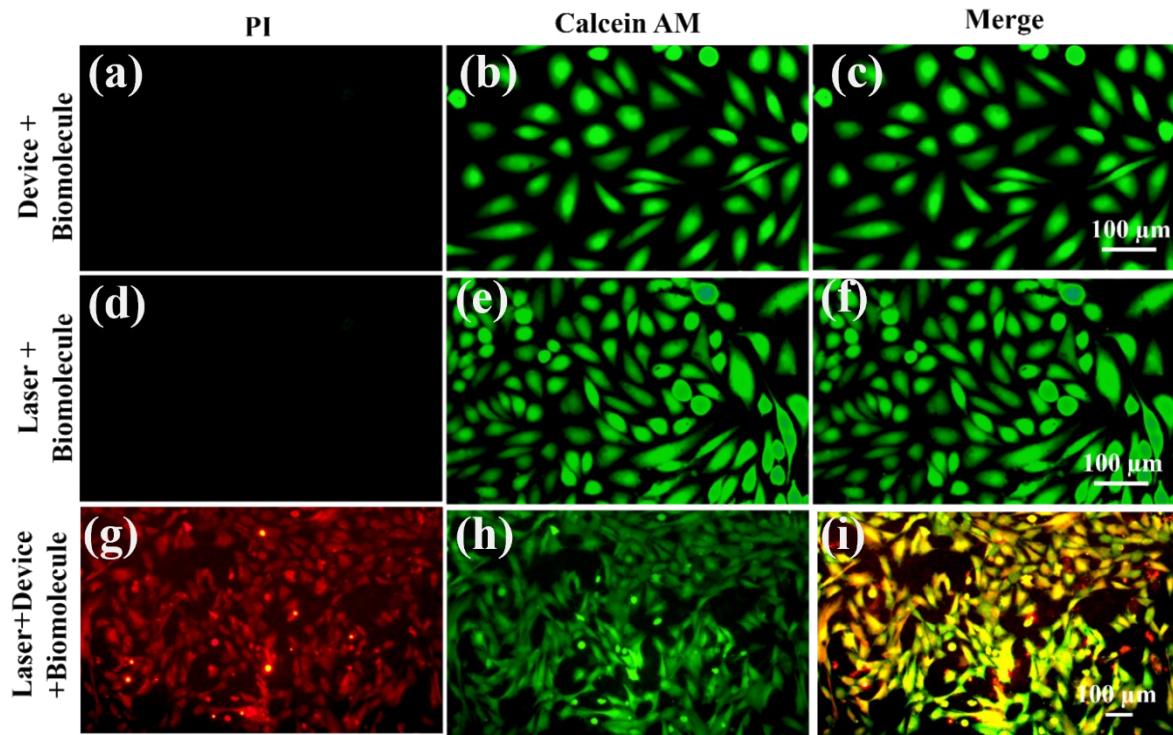
**Fig S6:** Scanning speed optimization studies. Images captured after performing photoporation in L929 cells with different scanning speed (10 mm/s, 9 mm/s, 6 mm/s)



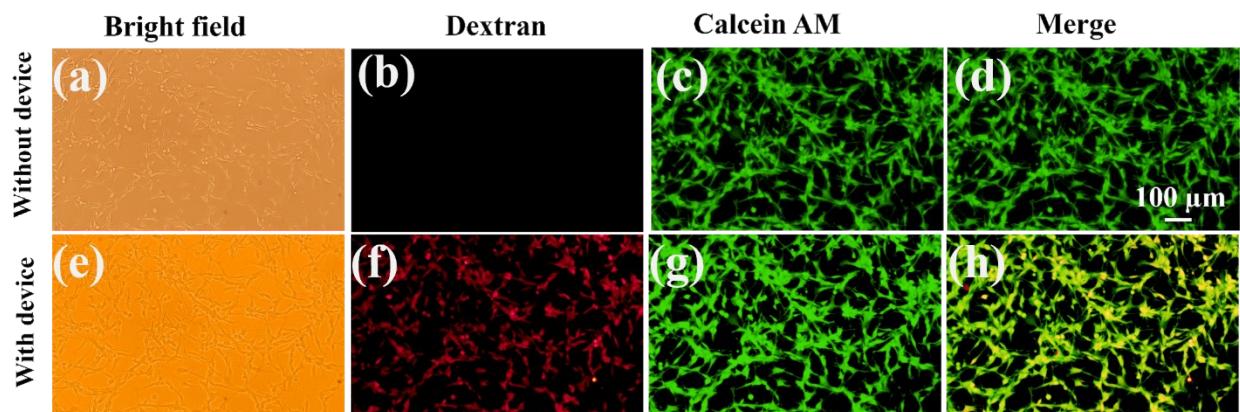
**Figure S7:** Flow cytometry data for the dextran 3000 delivery using rGO mixed PDMS device. (a) shows total cell count, out of which (b) shows percentage of live cells in the sample, (c) shows percentage of cells delivered with dextran, and (d) shows percentage of viable cells which are delivered.



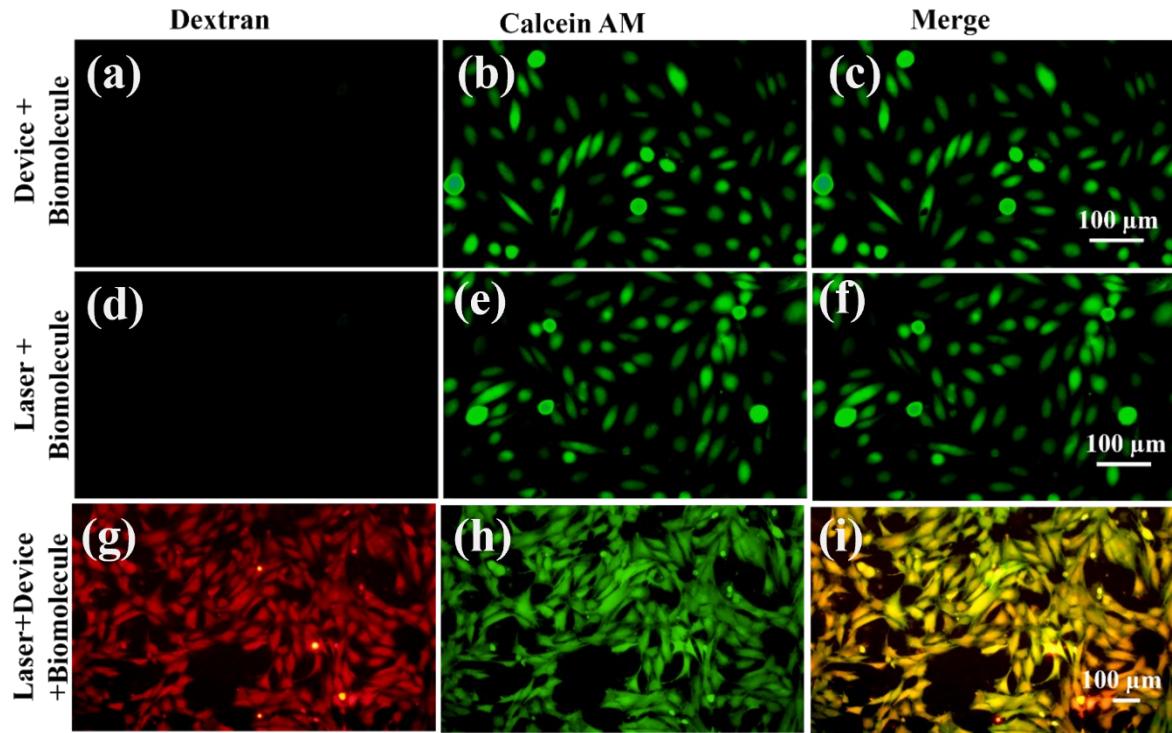
**Fig S8:** Control experiment for PI dye delivery in L929 cells. (a-c) without laser exposed on cells without a device with biomolecules, confirm no PI dye delivery (red), calcein AM (green) shows live cell image and merge image confirms most the cells are live (d-f) laser exposed on cells without a device and with biomolecules, which confirms no PI dye delivery (red), calcein AM corresponding live cells and the merged image confirmed all cells are live (g-i)laser exposed on cells with a device with biomolecules confirm PI dye delivery (red), calcein AM image (green) confirm the live cell and merge image (green to yellowish green) confirm the live cell after PI dye delivery.



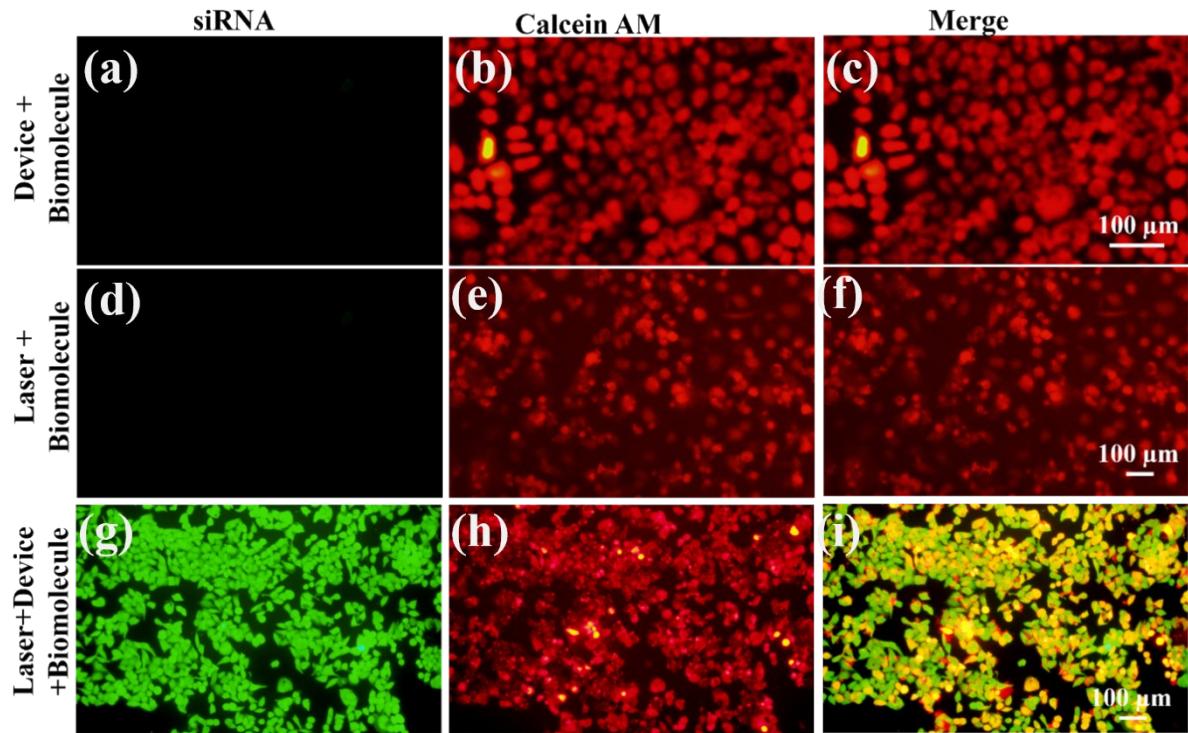
**Fig S9:** Control experiment for PI dye delivery NIH3T3 in cells. (a-c) without laser exposed on a device with biomolecules, confirm no PI dye delivery (red), calcein AM (green) shows live cell image and merge image confirms most the cells are live (d-f) laser exposed on cells without a device and with biomolecules, which confirms no PI dye delivery (red), calcein AM corresponding live cells and the merged image confirmed all cells are live (g-i) laser exposed on a device with biomolecules confirm PI dye delivery (red), calcein AM image (green) confirm the live cell and merge image (green to yellowish green) confirm the live cell after PI dye delivery.



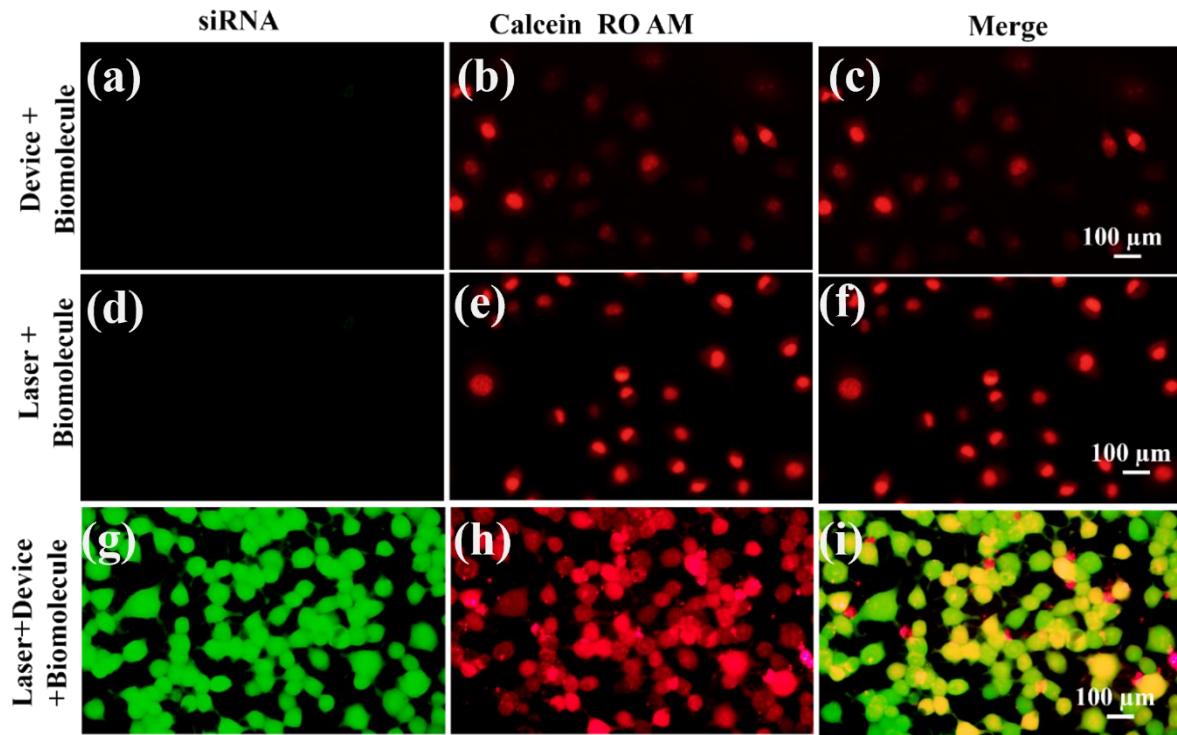
**Fig S10:** Control experiment using dextran 3000 Da delivery in NIH3T3 cells. Cells exposed to laser after adding biomolecules without incorporating rGO mixed PDMS sheet device (a-d), and cells exposed to laser after adding biomolecules with rGO mixed PDMS sheet device placed on top of cells (e-h).



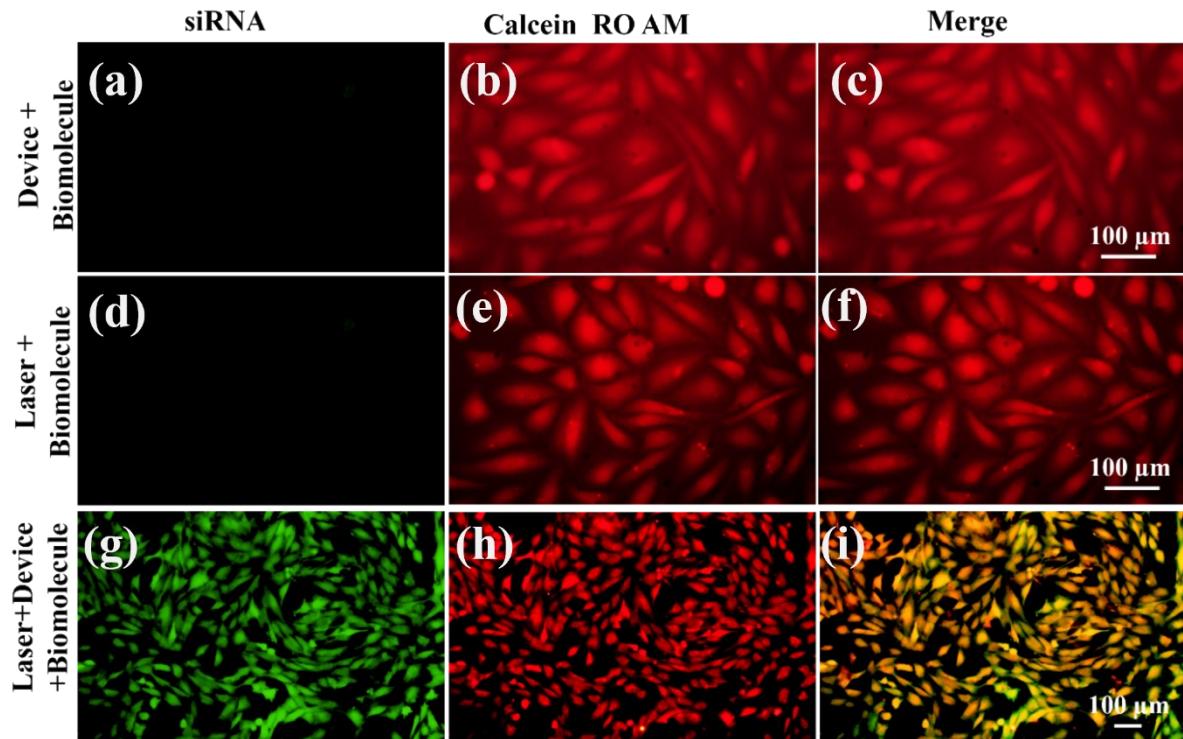
**Fig S11:** Control experiment for 3kDa Dextran delivery in NIH3T3 cells. (a-c) without laser exposed on a device with biomolecules, confirm no dextran delivery (red), calcein AM (green) shows live cell image and merge image confirms most the cells are live (d-f) laser exposed on cells without a device and with biomolecules, which confirms no PI dye delivery (red), calcein AM corresponding live cells and the merged image confirmed all cells are live (g-i) laser exposed on a device with biomolecules confirm dextran delivery (red), calcein AM image (green) confirm the live cell and merge image (green to yellowish green) confirm the live cell after dextran delivery.



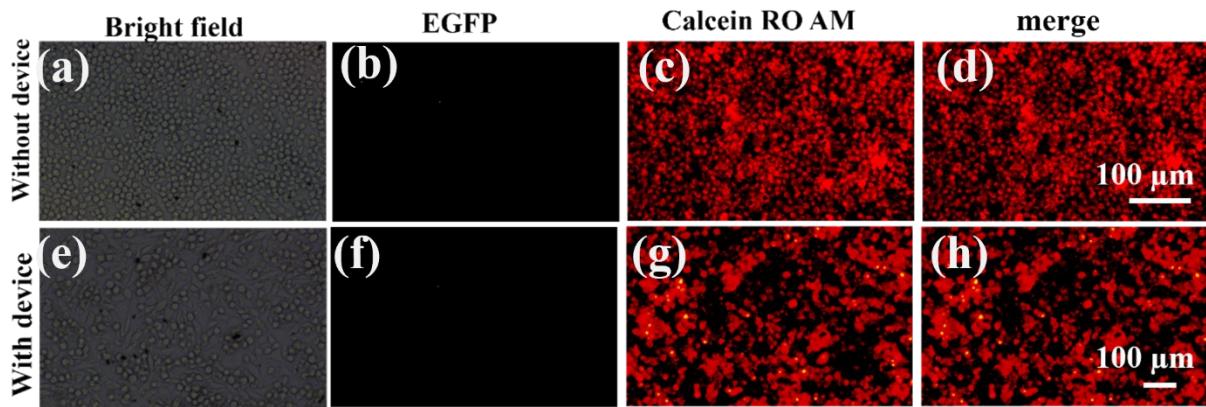
**Fig S12:** Control experiment for siRNA delivery in HeLa cells. (a-c) without laser exposed on a device with biomolecules, confirm no siRNA delivery (green), calcein image (red) shows live cell and merge image confirms most the cells are live (d-f) laser exposed on cells without a device and with siRNA biomolecules, which confirms no siRNA delivery (green), calcein image (red) corresponding live cells and the merged image confirmed all cells are live (g-i) laser exposed on a device with biomolecules confirm siRNA delivery (green), calcein image (red) confirm the live cell and merge image (green to yellowish green) confirm the live cell after siRNA delivery.



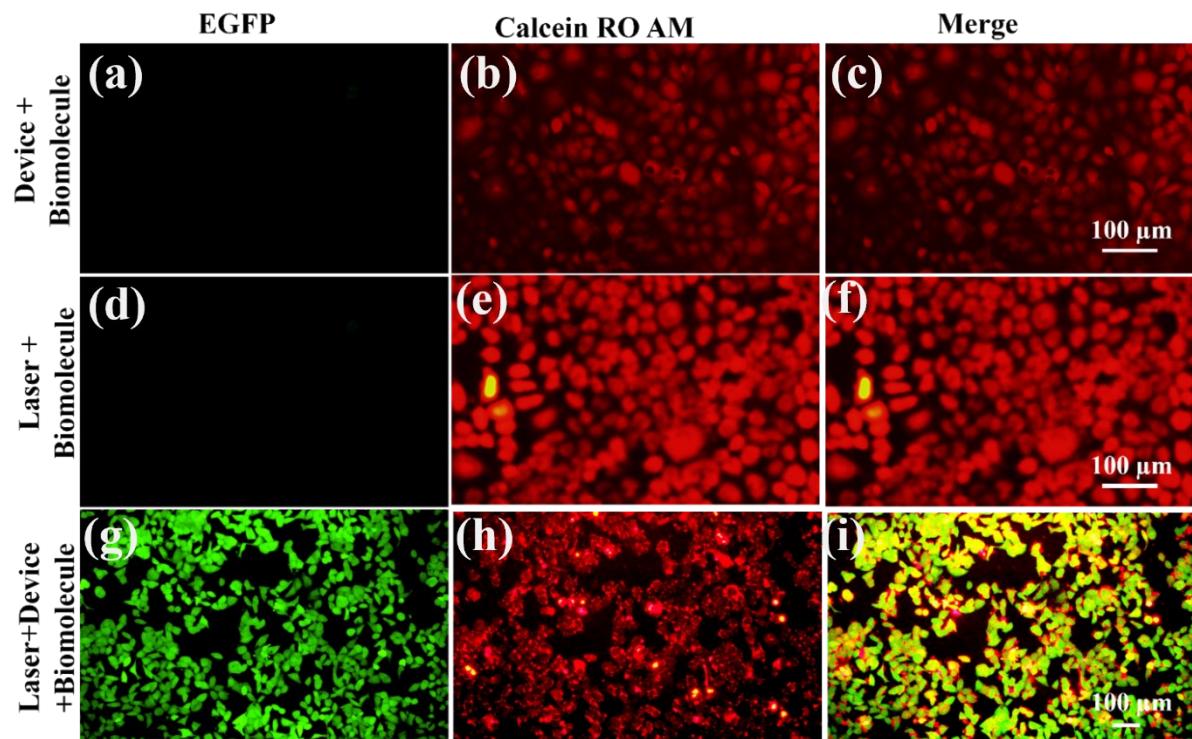
**Fig S13:** Control experiment for siRNA delivery in N2a cells(a-c) without laser exposed on a device with biomolecules, confirm no siRNA delivery (green), calcein image (red) shows live cell and merge image confirms most the cells are live (d-f) laser exposed on cells without a device and with siRNA biomolecules, which confirms no siRNA delivery (green), calcein image (red) corresponding live cells and the merged image confirmed all cells are live (g-i) laser exposed on a device with biomolecules confirm siRNA delivery (green), calcein image (red) confirm the live cell and merge image (green to yellowish green) confirm the live cell after siRNA delivery.



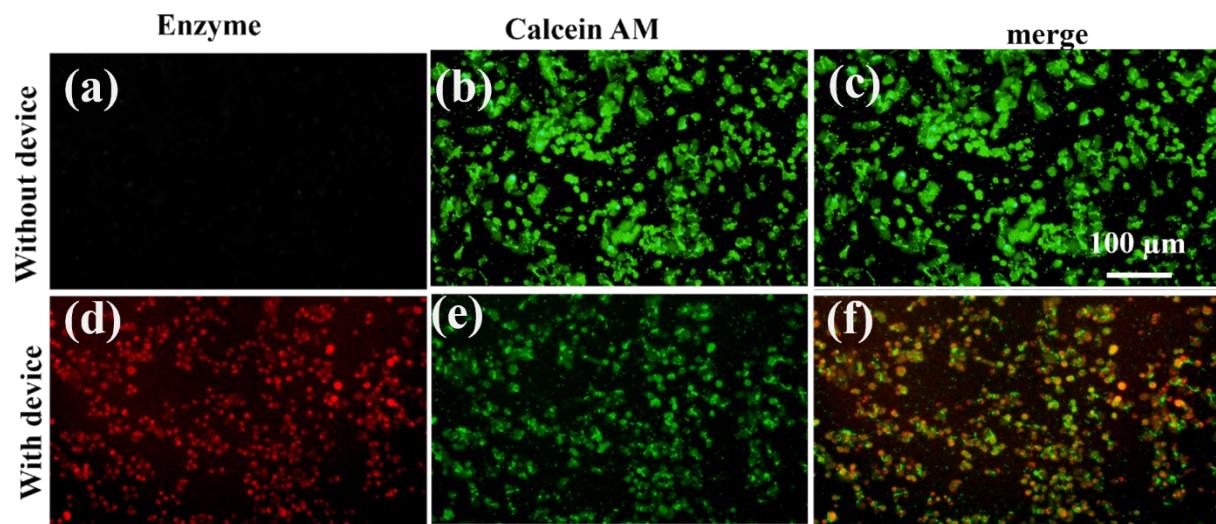
**Fig S14:** Control experiment for siRNA delivery in NIH3T3 cells. (a-c) without laser exposed on a device with biomolecules, confirm no siRNA delivery (green), calcein image (red) shows live cell and merge image confirms most the cells are live (d-f) laser exposed on cells without a device and with siRNA biomolecules, which confirms no siRNA delivery (green), calcein image (red) corresponding live cells and the merged image confirmed all cells are live (g-i) laser exposed on a device with biomolecules confirm siRNA delivery (green), calcein image (red) confirm the live cell and merge image (green to yellowish green) confirm the live cell after siRNA delivery.



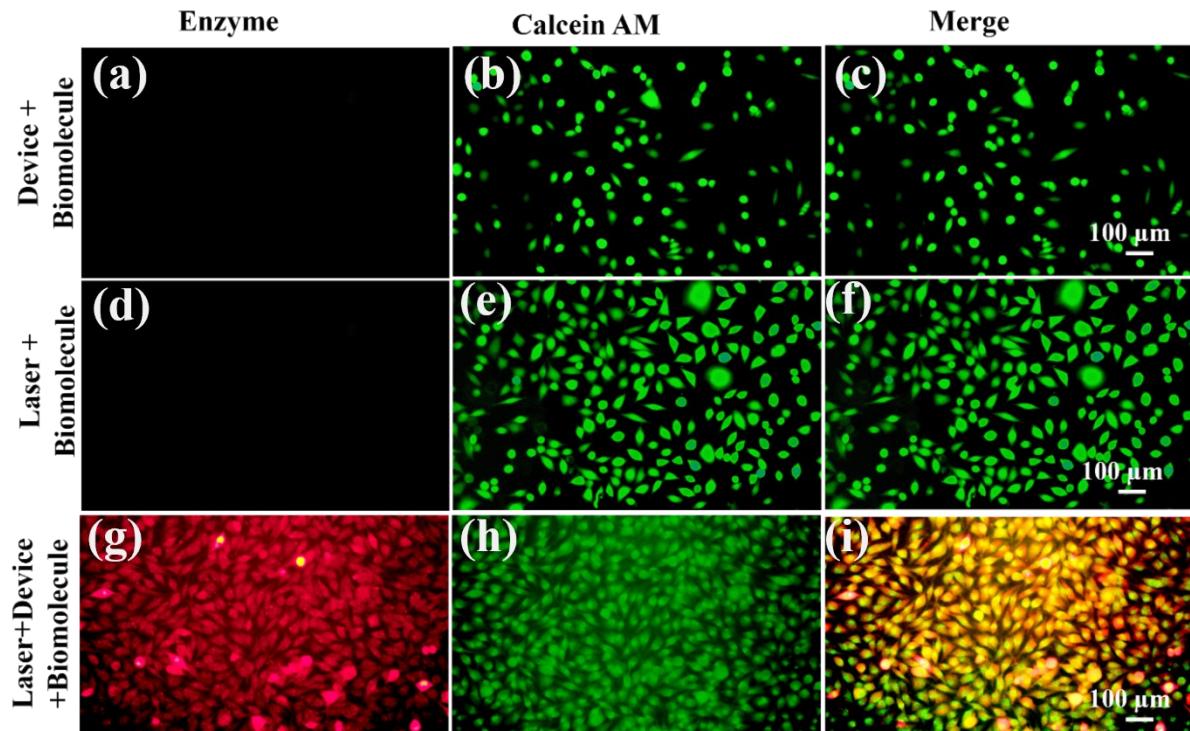
**Fig S15:** Control experiment for delivery of plasmid for EGFP expression in HuH7 Images. Cells exposed to laser after adding biomolecules without incorporating rGO mixed PDMS sheet device (a-d), and cells exposed to laser after adding biomolecules with rGO mixed PDMS sheet device placed on top of cells (e-h).



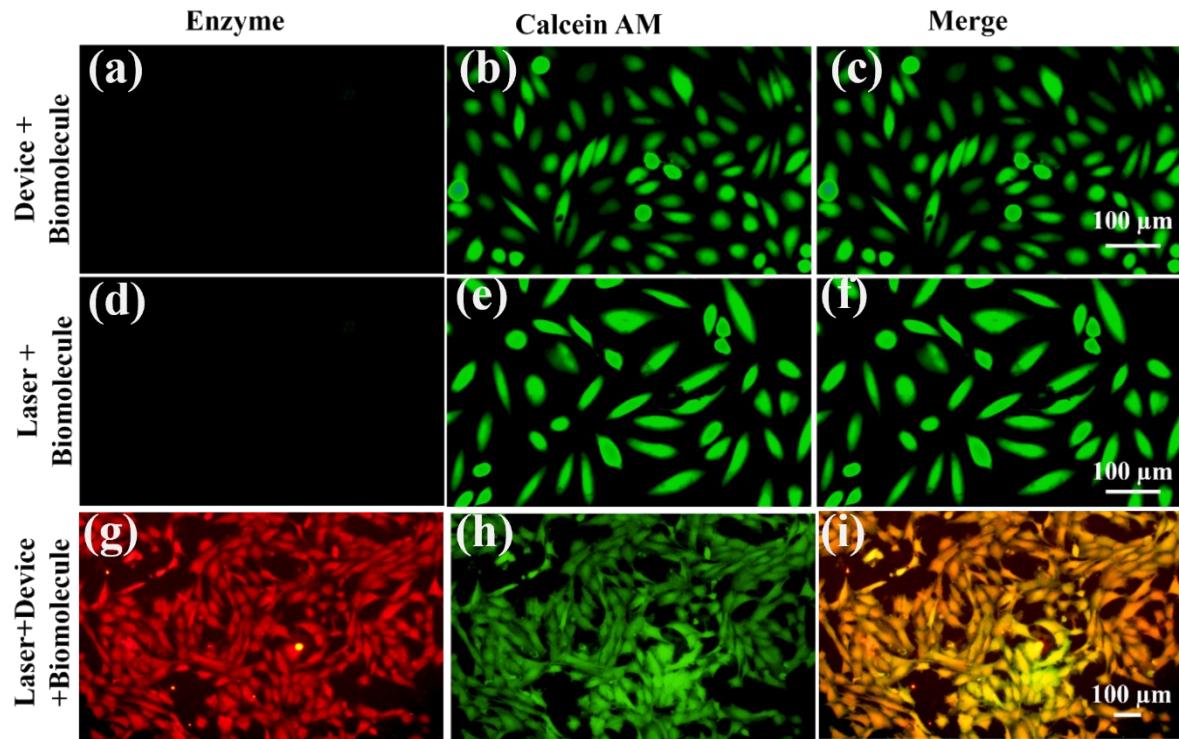
**Fig S16:** Control experiment for delivery of plasmid for EGFP expression in Hela cells. (a-c) without laser exposed on a device with biomolecules, confirm no plasmid for EGFP delivery (green), calcein image (red) shows live cell and merge image confirms most the cells are live (d-f) laser exposed on cells without a device and with EGFP biomolecules, which confirms no EGFP delivery (green), calcein image (red) corresponding live cells and the merged image confirmed all cells are live (g-i) laser exposed on a device with biomolecules confirm EGFP delivery (green), calcein image (red) confirm the live cell and merge image (green to yellowish green) confirm the live cell after EGFP delivery.



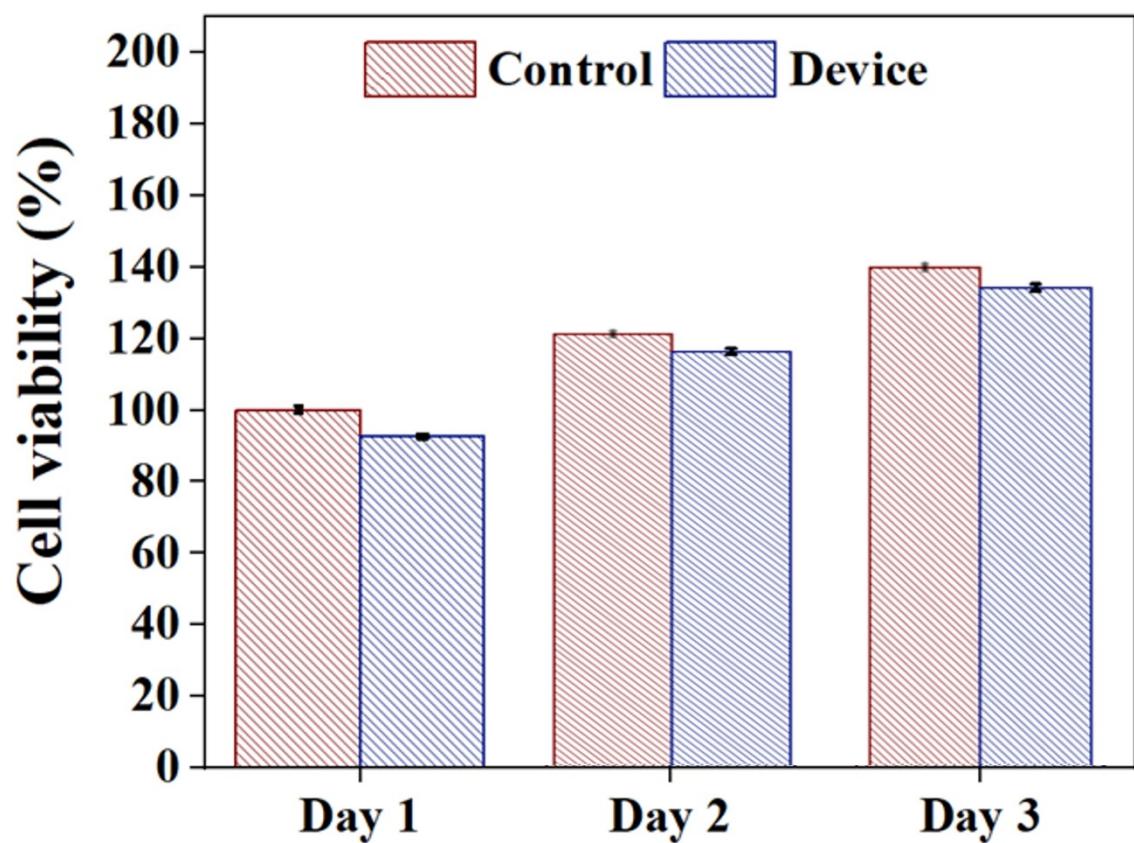
**Fig S17:** Control experiment for enzyme delivery in HuH7 cells. cells exposed to laser after adding biomolecules without incorporating rGO mixed PDMS sheet device (a-c), and cells exposed to laser after adding biomolecules with rGO mixed PDMS sheet device placed on top of cells (d-f).



**Fig S18:** Control experiment for enzyme delivery in L929 cells. (a-c) without laser exposed on a device with enzyme biomolecules, confirm no enzyme delivery (red), calcein AM image (green) shows live cell and merge image confirms most the cells are live (d-f) laser exposed on cells without a device and with biomolecules, which confirms no enzyme delivery (red), calcein image (green) corresponding live cells and the merged image confirmed all cells are live (g-i) laser exposed on a device with biomolecules confirm enzyme delivery (red), calcein image (green) confirm the live cell and merge image (green to yellowish green) confirm the live cell after enzyme delivery.



**Fig S19:** Control experiment for enzyme delivery in NIH3T3 cells. (a-c) without laser exposed on a device with enzyme biomolecules, confirm no enzyme delivery (red), calcein AM image (green) shows live cell and merge image confirms most the cells are live (d-f) laser exposed on cells without a device and with biomolecules, which confirms no enzyme delivery (red), calcein image (green) corresponding live cells and the merged image confirmed all cells are live (g-i) laser exposed on a device with biomolecules confirm enzyme delivery (red), calcein image (green) confirm the live cell and merge image (green to yellowish green) confirm the live cell after enzyme delivery.



**Fig S20:** Cytotoxicity studies. 3 day MTT assay performed on cells which haven't undergone optoporation(Control) and cells which underwent optoporation using our platform(Device).