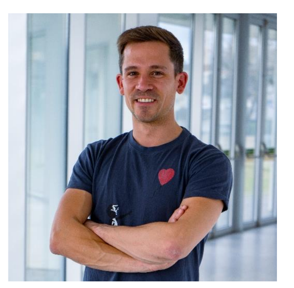
INTERNATIONAL IBERIAN NANOTECHNOLOGY LABORATORY

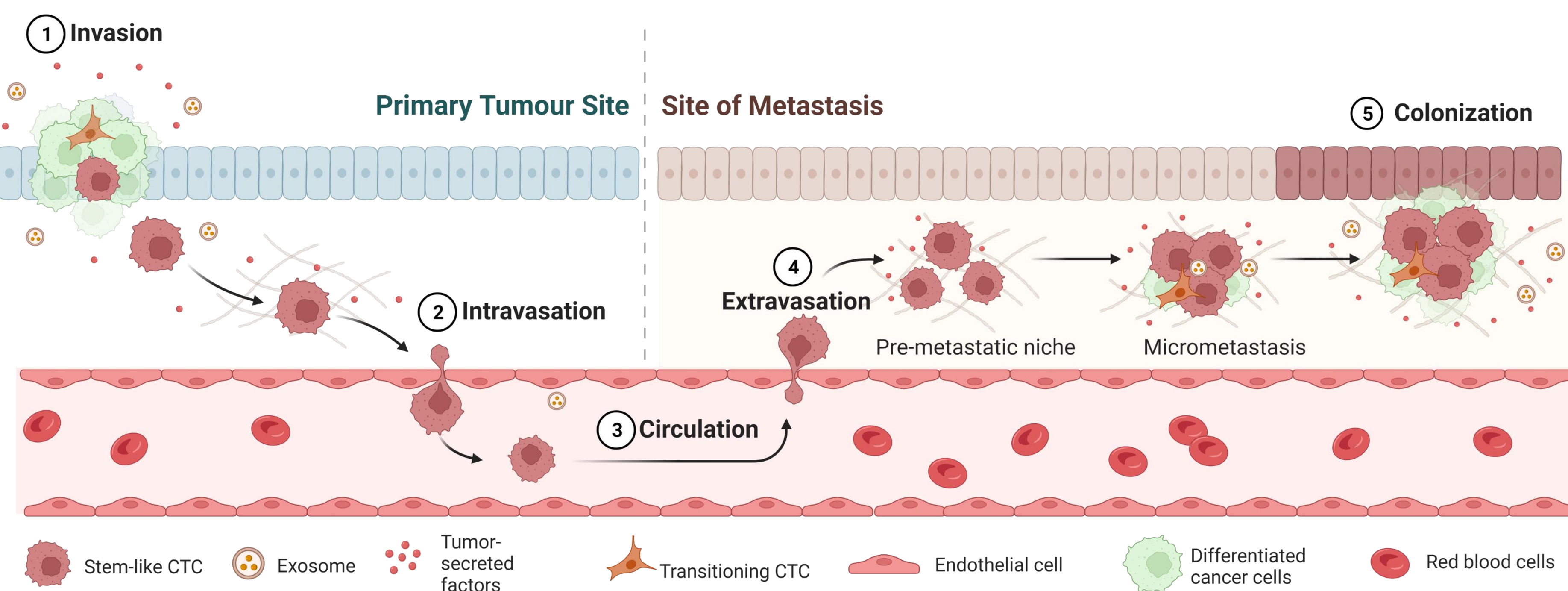


Microfluidics in Cancer Research

Miguel Xavier, Margarida Esteves, Carolina Rodrigues, José M. Fernandes, Hugo Silva, Carlos Honrado, Alexandra Teixeira, Lorena Diéguez, Sara Abalde-Cela

International Iberian Nanotechnology Laboratory, Av. Mestre José Veiga s/n, 4715-330 Braga, Portugal

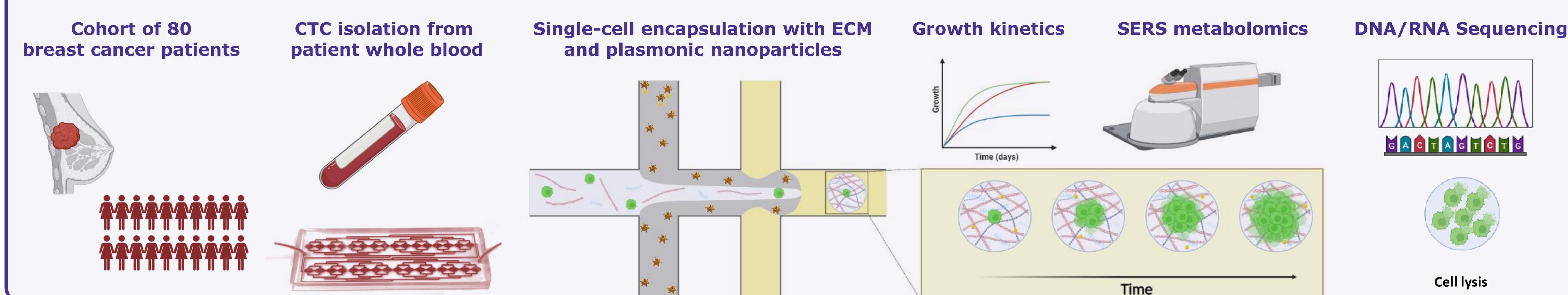
Introduction



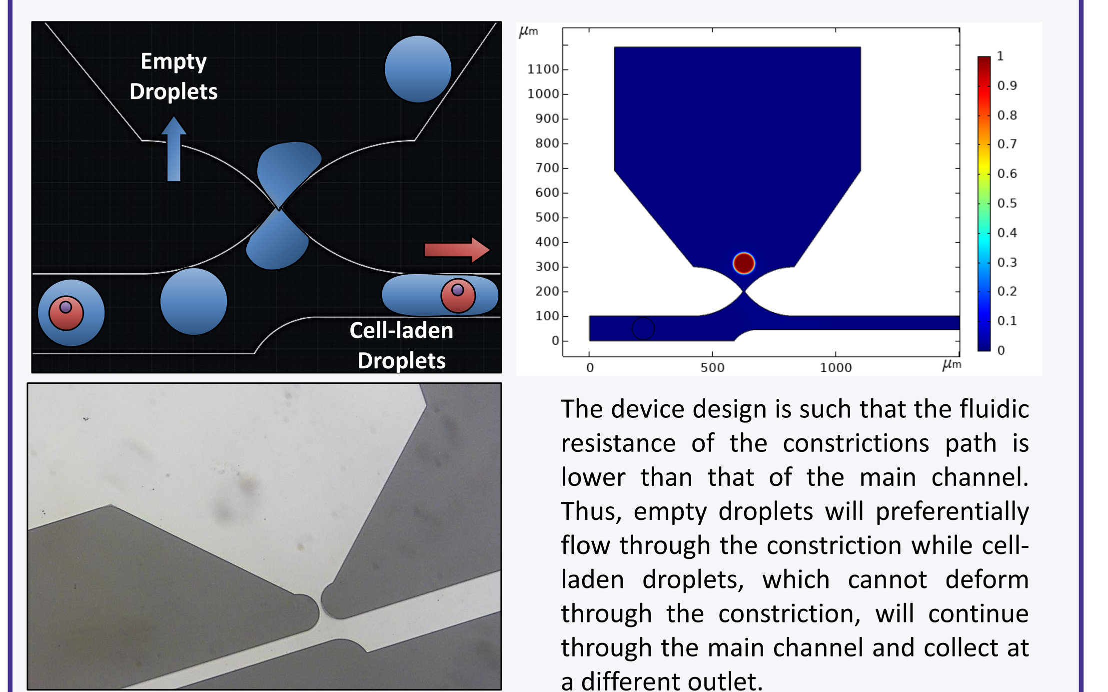
Cancer is a multifactorial disease that accounts for 1 in every 6 deaths that occur each year worldwide. It is thus no wonder that it has been coined the emperor of all maladies. One of the hallmarks of cancer is tissue invasion and metastasis. Indeed, metastases, rather than the primary tumour, are responsible for the majority of all cancer deaths, with some estimates setting this figure as high as 90%. Microfluidics offers myriad technologies that have the capacity to further our current understanding of fundamental cancer biology, lead to the discovery of innovative diagnostic methods, and provide new therapeutics via personalised medicine approaches. These include microfluidic isolation of circulating tumour cells and other cancer biomarkers, cancer cell analysis using nanosensors and SERS, the establishment of new cancer models based on organ-chips and cancer spheroids, among others.

Concepts & Methodology

Deciphering the metastatic potential of circulating tumour cells

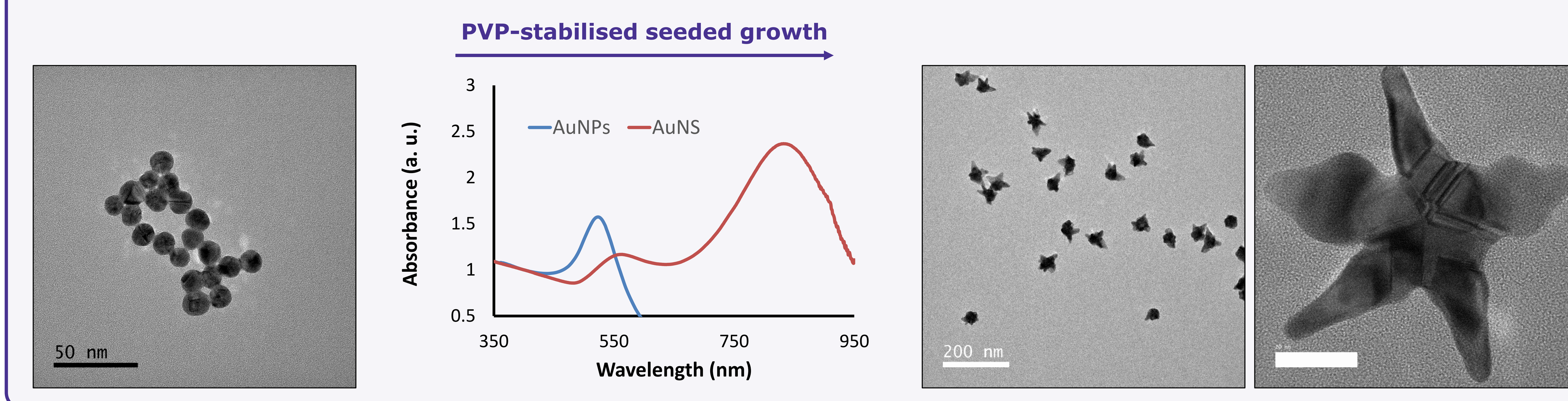


Droplet sorting

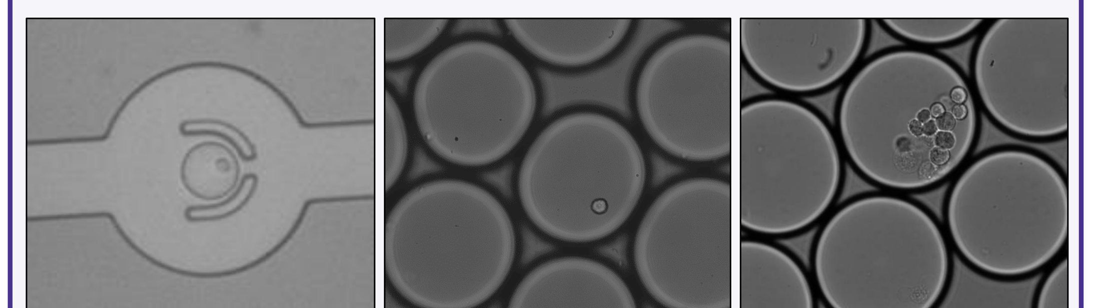


The device design is such that the fluidic resistance of the constrictions path is lower than that of the main channel. Thus, empty droplets will preferentially flow through the constriction while cell-laden droplets, which cannot deform through the constriction, will continue through the main channel and collect at a different outlet.

Plasmonic nanoparticle synthesis – Au nanostars

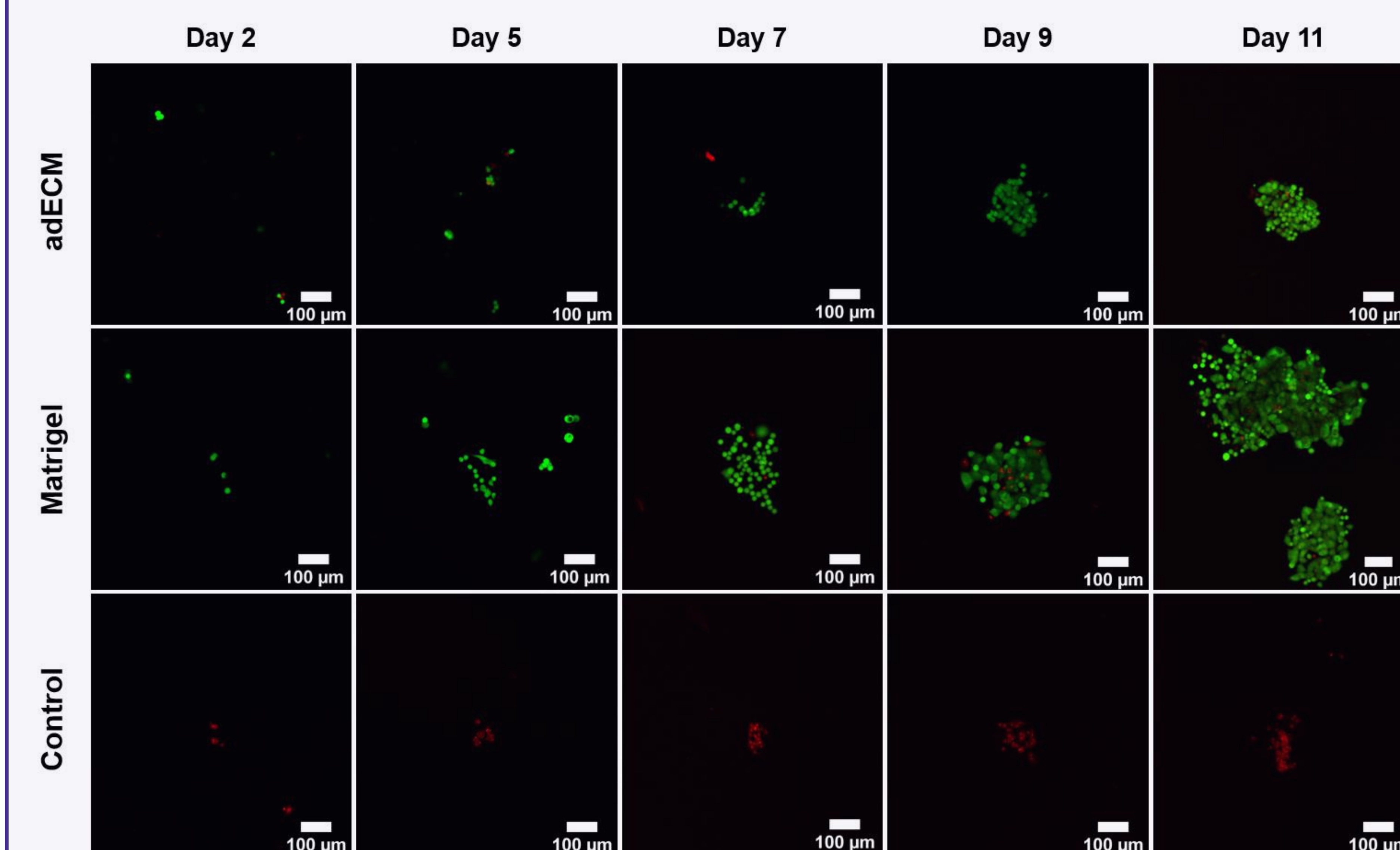


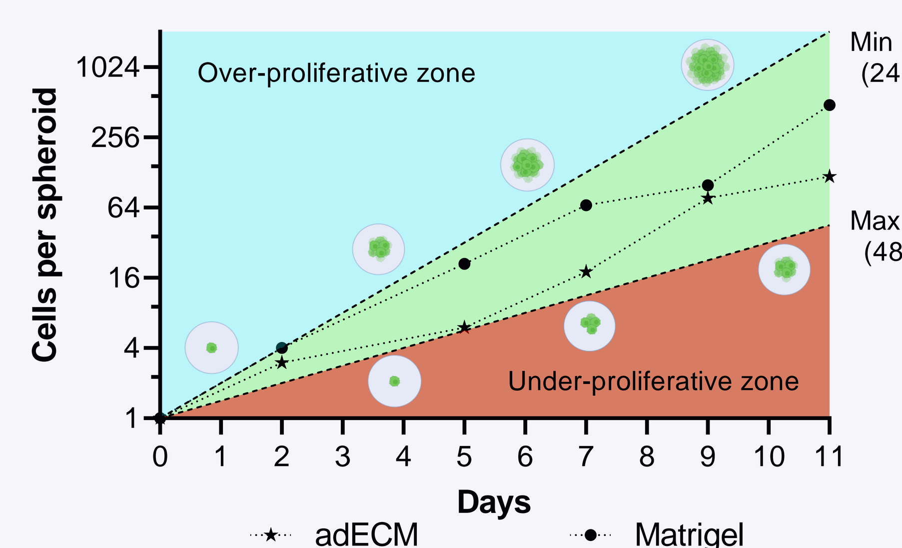
Droplet parking and incubation



Results

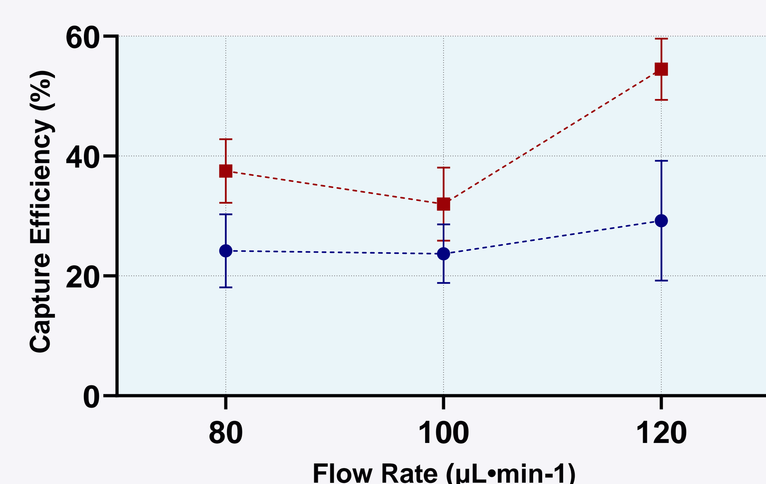
Cell proliferation from single cells within an ECM hydrogel





Cells were suspended in adECM or Matrigel at 10 mg/mL and cultured in 10-µL domes at the bottom of well culture plates (50 cells per dome). A live/dead assay was done at days 2, 5, 7, 9 and 11 of proliferation using Calcein AM and BOBO-3 and the number of live cells from representative spheroids manually counted for each condition. The expected cell proliferation rate (shaded green area) was estimated based on the maximum and minimum reported doubling time of the MCF-7 cell line.

CTC capture efficiency



Cancer cell lines (200 cells per 7.5 mL) were stained with Hoechst, spiked in healthy whole blood and flowed through the RUBYChip™. The number of captured cells was counted automatically using an image analysis algorithm.

Conclusion

- Cancer spheroids/clusters could be grown while maintaining high viability and starting from single cells within a human-derived extracellular matrix hydrogel.
- Next steps will include co-encapsulating cells with the plasmonic nanoparticles and test cell viability and the sensitivity of SERS analysis on-chip.

References

Acknowledgements

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