# Investigation of Microdevice Enhancement on Cancer Cell Analysis

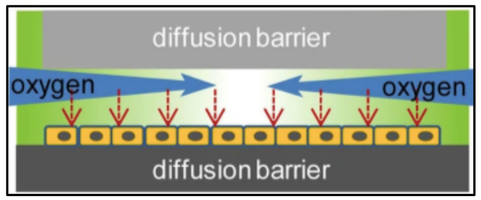
Yubin Lee (yubinlee617@gmail.com)
Laboratory for Integrative Biosystems Engineering
South Pasadena High School, Class of 2022
USC Viterbi Department of Biomedical Engineering, SHINE 2020

## Introduction

Cancer accounts for around 600,000 deaths each year in the United States only. In order to reduce these numbers, a deeper and more precise analysis must be obtained of cancer cells. There have been many techniques developed for this process and one of them includes microfluidic devices. In relation to cancer, these devices contribute to the process of fractionating tumor cells from the blood sample and help detect cancer in patients. In addition, they provide a plethora of benefits such as an inexpensive cost, optical transparency, and require minimal amounts of the tested fluid. Furthermore, these micro-devices are also applicable to many other processes in biomedical analysis such as blood plasma separation, DNA amplification, and predicting clinical outcomes through drug screening.

## Objective & Impact of Prof. Shen's Research

**Professor's Lab research:**

- Our lab primarily focuses on creating models that replicate the biological microenvironment for cancer cells, such as creating a hypoxic environment and stem cells.
- By doing this, researchers are able to study their response on the overall structure and chemicals surrounding them that results in therapy resistance.
- 

PC: Yuta Ando
- This platform had an overall structure of using two diffusion barriers that were able to create an oxygen gradient for the cells.

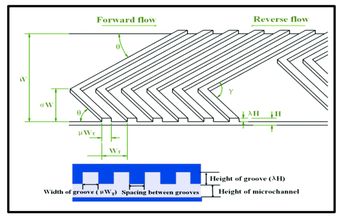
**Objective:**

- The objective of this research is to contribute to developing the future development of advanced cancer therapeutics, as well as contributing to the development of other medications and treatments.

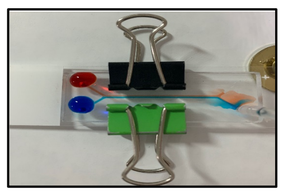
## Methods

**Microfluidic Device :**

- **Structure:** A polycarbonate mold is created through a 3D modeling software in order to shape the negative PDMS mold into the actual microfluidic structure
- **Mechanics:** Control device has a single channel branching out into two daughter channels at the beginning and the end.
- Herringbone device consists of patterned grooves on the inner surface of the main channel in order to create helical motions and combine the two fluids.




**non-herringbone device:**


PC: Yubin Lee

**herringbone device:**

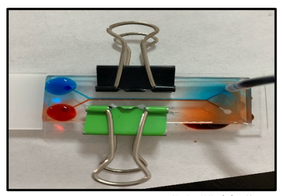
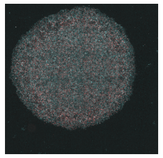
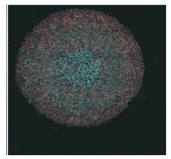

PC: Yubin Lee

**Image Analysis :**

- Images of immunostaining (process of using antibody-based method in order to expose protein expression) cells in both hypoxic and normal conditions were quantified by using Image J and MATLAB coding for a better analysis.
- Fluorescent intensities of each micropattern, as well as thresholding both images in order to accentuate their difference in oxygen levels, were considered when coding.
- The average intensity was taken from a region of interest from both images to obtain a greater accuracy.

normal environment.  hypoxic environment 
PC: Yuta Ando

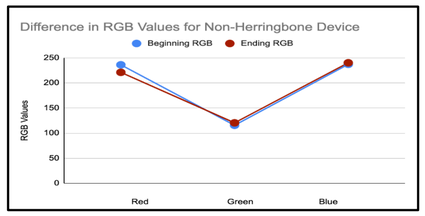
RED- Nuclei CYAN – Glut 1

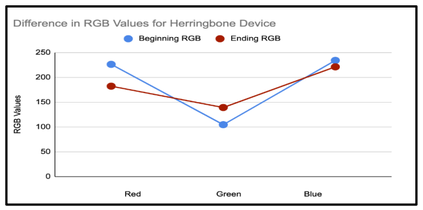
**Gelatin experiment:**

- Gelatin has been used in cell and tissue engineering due to its similarity in the molecular structure of collagen (the most abundant protein in the human body)
- Therefore, it was significant to understand the relationship between gelatin concentrations, and deflection.
- We tested 6 different gelatin concentrations by measuring how far an object would sink into each gel, ultimately measuring their stiffness after a given amount of time (4 ~ 8 hrs.)

## Results

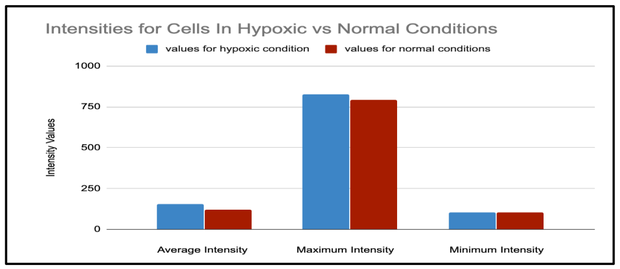
**Change in RGB Values for Microfluidic Device:**

- In order to fully assess the effects of each device, the average color intensity value for a set amount of pixels at the beginning of the channel, as well as the end, were analyzed, then compared.
- 

The control device showed little to no difference in the color values.
- 

Greater differences in the green values for the herringbone device, indicates successful mixing of the red and blue fluids.

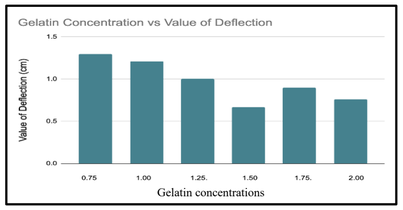
**Comparison of Fluorescence Intensities:**




- Data shows that the average and maximum value of the hypoxic environment was greater than that of a normal environment. This is because cancer cells upregulate the protein Glut-1 more than regular cells and therefore have greater fluorescence intensities.

**Impact of Gelatin Concentration on Gel Deflection:**

- Data shows that greater concentrations resulted in less deflection since it had greater stiffness.




- This data could be utilized in identifying the concentration trend that is most suitable for gelatin, in tissue engineering.

## Relation to STEM coursework

- SHINE has allowed me to explore cutting edge research and its detailed framework in biomedical engineering, which has assured me to continue in this pathway.
- It has also allowed me to expand my knowledge on innovative and efficient biomedical technologies that also incorporated many of the concepts I learned in school.

## References

[1] Ando, Y., Ta, H.P., Yen, D.P. *et al.* "A Microdevice Platform Recapitulating Hypoxic Tumor Microenvironments." *Sci Rep* **7,** 15233 (2017). doi.org/10. 1038/s41598-017-15583-3

[2] Wang, Minjiao, et al. "A Microfluidic Chip with Double-Sided Herringbone Microstructures for Enhanced Capture of Rare Tumor Cells." *Journal of Materials Chemistry B*, The Royal Society of Chemistry, 3 Nov. 2017, pubs.rsc.org/en/content/articlelanding/2017/tb/c7tb02318a.

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