SPEC-14-*[group #]*

PROJECT SPECIFICATION

APPROVALS

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Revision History

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-	Initial Release	*[mm/dd/yy]*	*[an approver]*
[A]	Trapezoidal and Rectangular electrode designs – Version 1	1/19/2015	*LA*
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E	Trapezoidal and Rectangular electrode designs – Version 5	2/3/2015	*LA*

Table of Contents

1 PROJECT SPECIFICATION OVERVIEW

1.1 Executive Summary

Recently, there has been a surging interest in cells known as cancer stem cells (CSCs). These cells are said to behave very similarly to normal stem cells in that they have the capability to self-renew and differentiate into more specialized cell types. In the case of the CSCs, they are capable of reproducing themselves and ultimately sustaining a cancer when they differentiate into the more commonly known tumor cells. The theory behind CSCs has immense implications. Currently, no cure for cancer exists but various cancer treatments and therapies do exist. These typically involve surgery, immune therapy, targeted therapy, hormone therapy, or chemotherapy. Many of these treatments focus heavily on killing rapidly dividing and growing cells, which is a characteristic of most cancer cells. However, with the introduction of CSCs, these treatments are generally rendered ineffective as they do not target the slower dividing CSCs. As such, CSCs can potentially cause a relapse after treatment even after all observable signs of cancer have been eliminated. Thus, our research team aspires to isolate these rare CSCs from normal rapidly dividing cancer cells in order to study them further. We believe that the study of CSCs may lead to a paradigm shift in the cancer field and may allow researchers to ultimately understand and target cancer at its core.

The function of the microfluidic device will be to separate the CSCs from other (non-tumorigenic) cancer cells by utilizing differences in polarizability between different cell types. In living cells, electrically charged ions are exchanged across the cell membrane. Previous research has proven that cells that are tumorigenic exhibit higher membrane capacitance than non-tumorigenic (i.e. regular) cancer cells. Through dielectrophoresis (DEP), this microfluidic device will separate the CSCs from the cancer cells by creating a non-uniform electric field within a network of interdigitated electrodes, as shown in Figure 2. Positive DEP forces will cause the CSCs to move towards the electrodes with the highest field concentration, and while CSC cells are retained within the electrode network, other cells can be washed out of the system. Two different designs will be tested. One design will use the material polydimethylsiloxane (PDMS) to create the channels which the fluid will run through and the other design will use CNC machined plastic.

2 Product Description

2.1 Product Context

The purpose of this device is to serve as research tool. In order to understand cancer, the actual cells that are promoting its spread and regeneration, CSCs, must be analyzed by itself. This device will enable a user to separate the CSCs among other cells in a blood sample to understand how CSCs function and work. This will aid in the development of therapies and treatments to defeat cancer.

2.2 User Characteristics

The user will be a university or lab researcher studying cancer, specifically understanding its characteristics and functions. This tool may also appeal to a pharmaceutical industry that specializes in developing cancer medicines, so they can create a drug that will help destroy CSCs.

2.3 Assumptions

It will be assumed that the densities, cell membrane capacitance and size of the non-tumorigenic cells are about the same, as well as the CSCs.

2.4 Constraints

There should not be any constraints with these designs.

3 Requirements

3.1 Functional and Performance Requirements

At least 80% of the CSCs should be captured from a sample in order to consider the experiment as a success. No leakage should be present as the fluid flows through the channels.

3.2 User Requirements

The user should be a researcher working in a lab and understand the proper safety protocols when handling bodily fluids. They should have knowledge on how to work a function generator and how to collect fluid undergoing capillary action.

3.3 Maintenance Requirements

The device should be kept in room temperature.

3.4 Standards Compliance

3.5 Deleted or Deferred Requirements

4 Appendix

4.1 Definitions, Acronyms, and Abbreviations

DEP: Dielectrophoresis
CSC: Cancer Stem Cell
PDMS: polydimethylsiloxane
CNC: Computer Numerical Controlled

4.2 References

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