Product Design Specifications – February 2, 2011

Project #60: Cell Scaffold

Team Members

Vivien Chen – BSAC
Sarah Czaplewski – BWIG
Vanessa Grosskopf – Communicator
Josh Kolz – Leader
Sarah Sandock – BSAC

Problem Statement

Assessing the progression and response to treatment of cancer may be possible by characterizing the metabolic state of cancer cells. Currently, our client uses MRI hyperpolarized carbon-13 labeled pyruvate to evaluate the metabolism of cancer. The objective of our project is to develop a cell scaffold for maintaining the cancer cells within a MR-compatible bioreactor. Cells must adhere and proliferate on this scaffold to sufficiently high densities and sustain viability for visualization of the pyruvate.

Client Requirements

- Grow specified cancer cells to a high density
- Maintain cell viability
- Use materials for scaffold that are compatible with the MRI machine and bioreactor
- Allow sufficient nutrients and experimental agents (i.e. ^{13}C-pyruvate) to reach the cells

Design Requirements

1. **Physical and Operational Characteristics**
    a. *Performance Requirements:* Cells must attach to scaffold and populate it. The scaffold should be coated with a substance that provides evenly distributed cell attachment sites. Also, the chemical interaction between the cells and the scaffold must be minimized. Ideally, a universal scaffold will be used for all cell types tested including Lymphoma K562, Leukemia NKL, Prostate PC3, DU145, LNCaP, U251 and U87 Brain Glioma, and T47D human breast cancer cells.

    b. *Safety:* No ferrous materials may be used in the construction of the scaffolds for the safety of the person conducting the study using the MRI machine.

    c. *Accuracy and Reliability:* Scaffold should maintain cells at a density of approximately $50x10^6$ cells/mL and sustain cell viability for the duration of the experiment which is approximately 1 hour. Also, The scaffold must grow cells to approximately the same density in every use for easy comparison between experiments.

    d. *Shelf Life:* The 3D structure of the scaffold should last 5 years and if a separate coating formulation is used, it should last at least one year.

e. *Life in Service:* The scaffold can either be disposable or reusable. If it is disposable, the scaffold will be used for one experiment (1 hour) plus the time it takes for the cells to adhere to the 3D structure. If the scaffold is reusable, it should last for at least one month.

f. *Operating Environment:* Scaffold will be perfused in a medium to the specific cell type being tested and housed in a MR-compatible bioreactor.

g. *Ergonomics:* User should be able to easily apply and remove scaffold from bioreactor.

h. *Size:* In previous studies, cell scaffolds were placed within an NMR tube inside a bioreactor. The bioreactor we are using is currently being developed by another team and the inner chamber size has not yet been specified. However, the bioreactor must be able to fit in the 3 inch diameter bore of the MRI machine magnet. Thus, the 3D structure of the scaffold will be smaller than 3 inches in diameter and the coating on the structure should be less than 1 mm thick.

i. *Weight:* The weight of the scaffold should not exceed 200 grams.

j. *Materials:* The scaffold materials should minimize chemical interaction with the cells and be biocompatible. Also, the material used should be MR-compatible and contain no ferrous metals. If the scaffold is designed to be reusable, the materials should be autoclave safe.

k. *Aesthetics:* The appearance of the scaffold is not pertinent to this project.

2. Production Characteristics

a. *Quantity:* The quantity depends on if the scaffold is designed to be reusable or disposable. However, the team should focus on making one scaffold which could be reproduced by the client as he sees fit. Also, one generic scaffold for all cell types is ideal but a scaffold tailored to each of the 8 cell types specified would suffice if needed.

b. *Product Cost:* The budget for the bioreactor and cell scaffold together is between $2000 and $3000. The scaffold should take up a smaller portion of this budget.

3. Miscellaneous

a. *Standards and Specifications*: There are no standards or specifications set by any organization that the project must follow. The scaffold will be designed with the standards and specifications set by our client.

b. *Competition*: Currently, there are a wide variety of scaffold structures and coating used in cell culture. Many types are commercially available such as microcarriers (small beads coated with ECM proteins), hollow fiber scaffolds, and 3D gel structures made of ECM proteins. Still, many other methods have been developed by research labs such as electrostatic calcium alginate encapsulation and the formation of cellular spheroids.