

# Product Design Specifications – December 3, 2009

## Cartilage Loading Project (Project #47)

### Team Members:

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### Problem Statement:

The goal of our project is to develop a bioreactor specifically designed to secure cartilage tissue during magnetic resonance (MR) scanning and provide mechanical loading during this scanning. This will allow researchers to look at the percent water composition of the cartilage under different loading. This is also a non-invasive method that could prove to be an accurate measure of cartilage maturity in the future.

### Client Requirements:

- Biocompatible
- Ability to be sterilized
- Can be used in magnetic resonance (MR) scanner
- Apply mechanical load to tissue samples

### Design Requirements:

#### **1.) Material Characteristics**

- Temperature:* The materials must not deteriorate when held at temperatures near 37°C indefinitely as it is meant to simulate human internal conditions.
- Biocompatible:* The bioreactor will be holding living tissue, so it must be biocompatible with human tissue.
- Sterilize:* The bioreactor should be able to withstand any type of sterilization that is currently used, including autoclaving and chemical sterilization.
- Insulation:* Ideally the bioreactor will be able to keep its internal temperature at 37°C for 6-8 hours, but it must not lose more than 5°C in that time.
- Metal:* There cannot be any ferrous metal in close proximity to the cartilage because this will alter the results produced by the scanners. Ideally, no metal will be used during the construction process.
- Transparence:* The tissue should be visible from the outside of the container to allow for frequent visual checks on the tissue.

#### **2.) Physical Characteristics**

- Size:* Must fit inside a 3-inch diameter scanner (with a cylindrical shape).

- b. *Leaking*: The bioreactor cannot leak any of the medium that the tissue is growing in.
- c. *Cap*: There must be a cap on the bioreactor to allow researchers to monitor the tissue grow and to replace the medium.
  - i. This cap must be secure and not leak when closed.
  - ii. This cap needs to be large enough to insert the sample.
- d. *Not Air Tight*: Cells need to breathe, so the bioreactor should have either some sort of air exchange with the surrounding environment or a medium exchange apparatus to ensure adequate oxygen during the scan.

### 3.) **Fixation Characteristics**

- a. *Movement*: The tissue cannot move at all once it has been loaded in the bioreactor specifically as it is transferred into the scanner.
- b. *Height*: The tissue must be elevated off of the bottom of the bioreactor to allow room for the mechanical loading.
- c. *Internal*: The fixation should be on the inside of the bioreactor as to not introduce possible sites for leakage.
- d. *Sample size*: Ideally the fixation device should be able to adjust to different sample sizes, but at a minimum it should hold a disk shaped sample of proportions: 1.5 cm radius and 3 mm height.

### 4.) **Mechanical Loading**

- a. *Compression*: The bioreactor should have a mechanism for providing a compressive force on the tissue sample up to 20% compression.
- b. *Adjustable*: The force should be able to easily adjustable by the researcher.
- c. *Measurements*: The force should be deliverable from 5-20% in 5% increments. This amount should be visible and easily set.
- d. *Longevity*: The compressive force must remain at the same pressure throughout a 6-hour scan.