INNOVATIVE DESIGN & FABRICATION OF A MICRO-CENTRIFUGE TEST TUBE TO ACCURATELY MEASURE CELL ADHESION QUALITIES

PROBLEM STATEMENT:
Our goal is to design and fabricate a unique micro-centrifuge test tube that will allow for a more accurate and simple process for measuring the force of cell adhesion to a surface or other cell.

BACKGROUND:
In healthy tissues and organs, individual cells are connected to other cells as well as basally to a surface known as the extracellular matrix (see Figure 1 to the left). However, in some disease states such as cancer, the cells become damaged and lose their ability to remain adhered to other cells or the extracellular matrix. In this state, cells migrate throughout the body instead of remaining in place. Attempting to understand these adhesion forces plays a crucial role in the design of the scaffolds for human tissue grafts and artificial organs. The present challenge is that there is no convenient way to accurately measure the force required to detach a cell from its surface. Currently, when comparing cell adhesion to different surfaces or between different cells, the method used is rather crude. It involves adding up individual cells on a surface and rinsing them off either by hand or with a robotic arm. A different method to apply a force with a specific magnitude and direction is centrifugation. High-speed centrifuges, such as the ones found in most life science research labs (see Figure 2), can generate the forces necessary to separate animal cells.

DESIGN PROGRESSION:

• Disposable
• One end at 45° angle (test tube)
• Other end internally threaded (test tube)
• Screw cap
• No air bubbles

CAP DESIGN #1:
Features: Angled at 45°, housed cover slide on angle
Drawbacks: Cost, disposability, cover slide frailty

CAP DESIGN #2:
Key Features: Internal cone, hollow inner cap
Theory: Air passes through cone and is trapped in hollowed area when screwing on the cap
Drawbacks: Air bubbles were not contained during centrifugation

CAP DESIGN #3:
Key Features: Internal horn shaped funnel
Theory: Funnel reduces surface area and increases the hollow area to store the bubble
Drawbacks: Same as design #2

CAP DESIGN #4:
Key Features: Leur Lock Valve
Theory: Valve open when screwing in allows any air to pass through, close valve once air has passed
Drawbacks: Cost, disposability and manufacturability

FINAL DESIGN:
Key Features: Test tube has a changing inner diameter
Theory: When tube is filled to a certain level, the changing inner diameter of the tube combined with its matching cap prohibits the formation of air bubbles

DESIGN REQUIREMENTS: