Executive Summary: BME Design Excellence Award, BME 402

Microscope Stage Top Cell Culture Incubator

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Observation and imaging of cell culture *in vitro* is an important part in understanding *in vivo* cell processes and studies. In order to most effectively represent the conditions of the *in vivo* environment, cell cultures are placed in incubators that maintain constant homeostatic conditions. The most important conditions to keep constant are temperature, humidity, and CO_2 concentration. However, when observing and imaging cells, the cells have to be removed from the incubator to be placed under the microscope. When imaging cells outside of the incubator for long periods of time, the cells are removed from their optimal environment, which can affect the way the cells live, grow, and interact. A microscope stage-top cell culture incubator could be used to eliminate the need to remove the cells from the incubator.

There are existing devices on the market including the World Precision Instruments Stagetop Environmental Chamber with Controller and the Ibidi Stage Top Incubation system. However, these devices are often very expensive to purchase, for example the World Precision Instruments Stagetop Environmental Chamber with Controller costs $11,500.00 and the Ibidi Stage Top Incubation system costs $13,990.00.

The team's proposed stage top incubator, can accomplish all of the necessary components of incubating cells, while costing under $500. The stage top incubator is fabricated from cheap, reliable, temperature resistant polypropylene plastic. There are two layers of the polypropylene, allowing for maximum heat retention within the incubator box. In between the layers of polypropylene there is also insulation, which further contains the heat within the box. Cut out of the top and bottom of the box are glass windows that allow for a large visual viewing inside of the box. The conditions are maintained in the box through an immersed heating source. The immersion of the heating source in water allows for even distribution of heat throughout the box, and also helps keep the humidity of the box high. In addition to maintaining heat, a solenoid valve and sensor controls the distribution of CO_2 within the incubator. All of the electronics are encoded on an Arduino microcontroller, allowing for easy modification to code and conditions, if that is deemed necessary by the researchers.

Various tests regarding the temperature and CO_2 concentration inside the box will be done to determine the incubator's viability. A temperature sensor placed on the inside the box will read the constant temperature being kept inside the box. The temperature it reads will be recorded at multiple different time points. A t-test will be performed to determine if the temperature varies significantly. A similar experiment and statistical test will be conducted on the CO_2 sensor.

The marketability of this device is extremely high because of the potential benefit it can have in educational settings. Many educational institutions would appreciate a stage top incubator to help teach students about imaging, cell culture techniques, among other things, but an incubator costing over $10,000 is not feasible. This product allows for a cheaper, effective alternative to the commercial products already on the market.