Perfusion Chamber with Elastic and Porous Membrane

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Function

The perfusion chamber will allow for control of the movement of fluid across human eye cells that are adhered to an elastic membrane. Variable pressure is to be applied from both the top and bottom of the cells. The device must allow for adherence of the elastic membrane to the culture plates, easy replacement of cell culture plates, and measurement of fluid pressure with computer-controlled transducers. In addition, a porous elastic membrane that permits fluid flow will replace the silicon membrane of the current system. A successful design will be used to screen for potential treatments of glaucoma.

Client Requirements

The prototype must be modified or redesigned to:

- Allow for simultaneous experimentation on three samples of human eye cells.
- Apply pressure to both sides of the permeable membrane supporting the cells.
- Incorporate a more appropriate permeable elastic membrane.
- Reduce the amount of serum required for experimentation.
- Increase contact of cells with oxygen.
- Prevent fluid leakage.
- Simplify the process of sterilization or incorporate inexpensive disposable materials.
- Allow for easy exchange of cell culture plates.

Design Requirements

Physical and Operational Characteristics

a. *Performance requirements:* The perfusion chamber prototype will be used to investigate the effect of varied fluid pressure on the extracellular matrix proteins of ocular cells to further glaucoma research. Consequently, the device must be designed with enough compartments to conduct triplicate experiments simultaneously. These wells must withstand pressures of forty millimeters of mercury without causing leakage or structural failure and should hold around five hundred microliters of cell culture media and drug treatment. Additionally, the system will be enclosed to deter contamination of the exposed cells when the device is in use. To provide a manner of measuring pressure and facilitating use, the developed system will be fully integrated with pre-existing technology, including an automated syringe pump with which to generate pressure, a pressure transducer to provide the output readings, and

the corresponding software for data collection. Finally, the system must be easily disassembled to allow for sterilization and then easily reassembled for overall ease of use.

b. *Safety:* Safety necessities to keep in mind are those preserving the health of the cell cultures. To prevent bacterial contamination of the experimental and laboratory environment, maintenance of the seal between the porous membrane and the individual wells is imperative.

c. *Accuracy and Reliability:* To ensure reliability of the research conducted with the perfusion chamber device, the designed prototype must be correctly integrated into the current system through connection with the pressure transducer, accurate to 0.5 mmHg, syringe pump, and corresponding software. Error in this integration could result in unreliable data collection and misinformed interpretations of results. In addition, the design of the treatment wells must maintain the separation and independence of individual conditions to ensure reliability of potential findings.

d. *Life in Service:* The perfusion chamber design must endure weekly experimentation of continuous twenty-four hour periods for at least five years. Consequently, the device must be constructed of material that can withstand frequent gas sterilizations and treatment with antibiotics. Also, the structural integrity of the design must endure weekly resistance to fluid pressure.

e. *Shelf Life:* The product will be stored on the laboratory bench in a controlled environment when not in use. The pressure source and transducers may be disconnected when not in use.

f. *Operating Environment*: The chamber must withstand up to 40 mmHg fluid pressure and 2.5 µL per minute rate of fluid flow. It must be resistant to the drugs perfused into the cell culture and to the antibiotics, UV light, and gas used for sterilization.

g. *Ergonomics*: Operator-controlled components must be easily reached on a typical laboratory bench. The system assembly and exchange of cell culture plates must be simplified for the operator. Improved ergonomics may contribute to greater ease and speed of experimentation.

h. *Size:* Product size should be minimized to facilitate use with other equipment in the laboratory, including the pressure source, pressure transducers, and a computer.

i. *Weight:* Product weight should be minimized to allow easy transport within the laboratory and possibly transport by vehicle to the UW School of Medicine.

j. *Materials*: Materials utilized must be sterilized using UV light according to the client's current sterilization procedure. Plexiglas was suggested as the primary material for prototype construction.

k. *Aesthetics*, *Appearance, and Finish*: A transparent prototype will maximize visibility of the experiment.

Production Characteristics

a. *Quantity*: One prototype is needed that allows for triplicates of sample experimentation.

b. *Target Product Cost*: The client will determine the final budget at a later stage of the design. The preliminary budget allowance is $2000, estimated from the cost of manufacturing the Plexiglas container that is currently in use.

Miscellaneous

a. *Standards and Specifications:* The product is not required to meet any national or international standards. All specifications are determined by researchers in Dr. Peters's laboratory.

b. *Customer:* Proper function and ease of use are the customers' primary concerns.

c. *Patient-related concerns:* The device is not for use with human or animal subjects.

d. *Competition:* Perfusion chambers with similar capabilities exist but require whole eyes rather than eye cell cultures. To our and Dr. Peters' knowledge, the product will be a novel device.