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BME 200/300
Microcosm for Bacteria and Plant Roots
September 23th, 2019

Criteria	Weight	Design 1: Lego		Design 2: Yanbo Match Box		Design 3: Sealed Jar		Design 4: Salina Puzzle Piece		Design 5: Xavier Fan Modular	
Transparency	25	5/5	25	2/5	10	5/5	25	5/5	25	5/5	25
Ease of manufacturing	25	3/5	15	2/5	10	2/5	10	5/5	25	3/5	15
Ease of Loading	15	5/5	15	5/5	15	5/5	15	5/5	15	5/5	15
Leakproof	15	5/5	15	5/5	15	4/5	12	5/5	15	4/5	12
Adjustability	10	0/5	0	0/5	0	3/5	6	0/5	0	5/5	10
Safety/Contamination	5	5/5	5	5/5	5	5/5	5	5/5	5	5/5	5
Cost	5	5/5	5	5/5	5	5/5	5	5/5	5	5/5	5
Total	100		80		60		78		90		87

Ease of loading: The top surface of the device needs to have holes to fix a location to load the bacteria in each experiment. The structure of the device needs to ease loading of culture media and sand before loading the bacteria.

Transparency: The distance from the root to the microscope has to be as minimal as possible, which means that the bottom of the device needs to be as thin as possible for more quality microscopy. The material has high transparency as well.

Ease of manufacturing: Increased modules and cutouts means that more time needs to be spent on manufacturing due to high difficulty and complexity. The difficulty of injection molding of PDMS depends on the shape of the specific design.

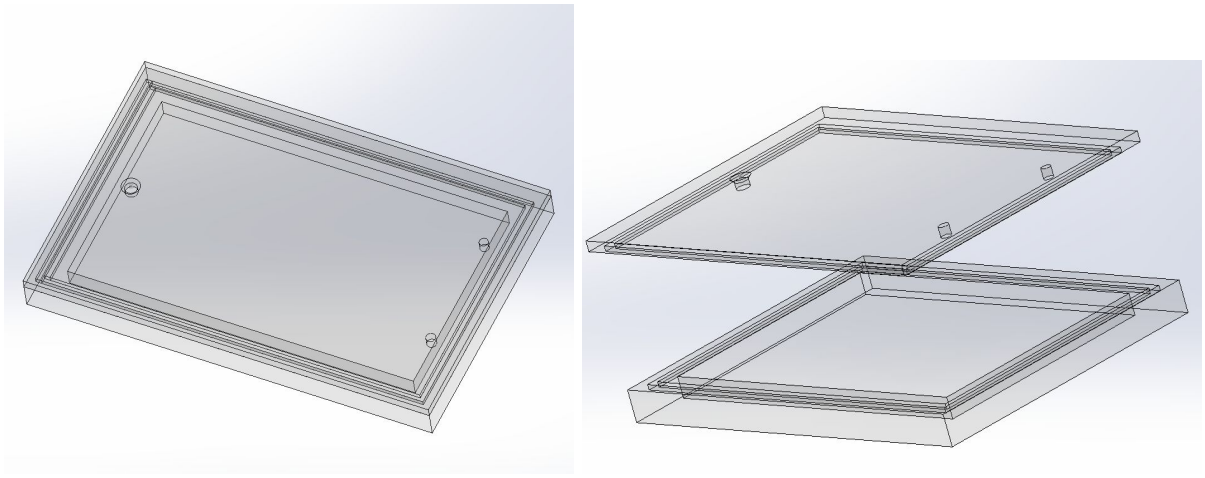
Leakproof: Changing the position of the device will cause leakage. Whether the chamber for holding liquid can be completely sealed is important for this design.

Adjustability: The height of the chamber can be adjusted to control the size of the chamber.

Safety/ Contamination: The potential of breaking glass can cause safety issues. Also the possible contamination of bacteria is also part of the safety concerns.

Cost: The material and fabrication process need to be both monetary and environmental economical.

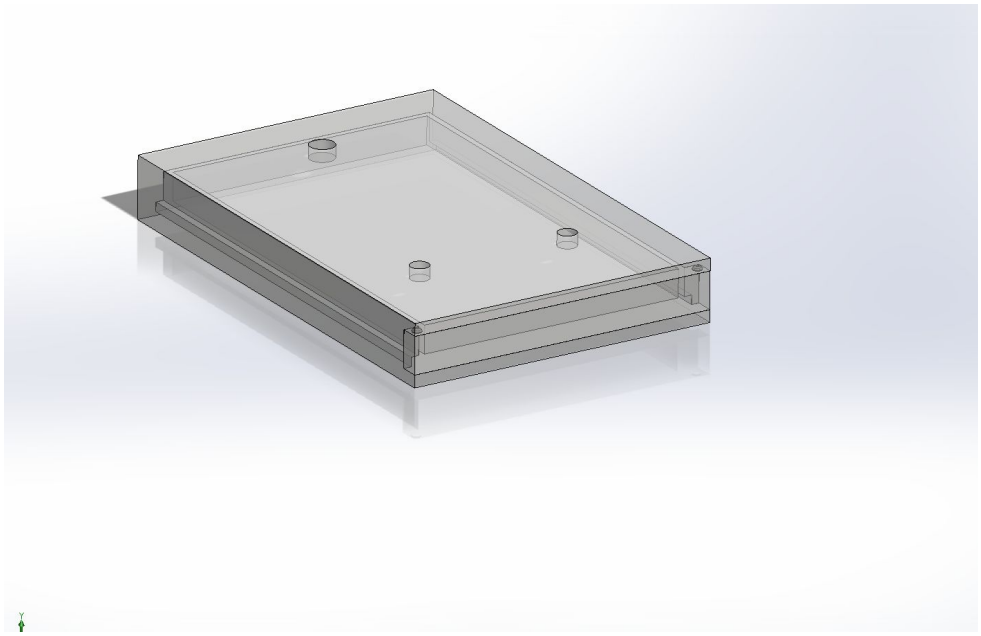
Design 1: Lego

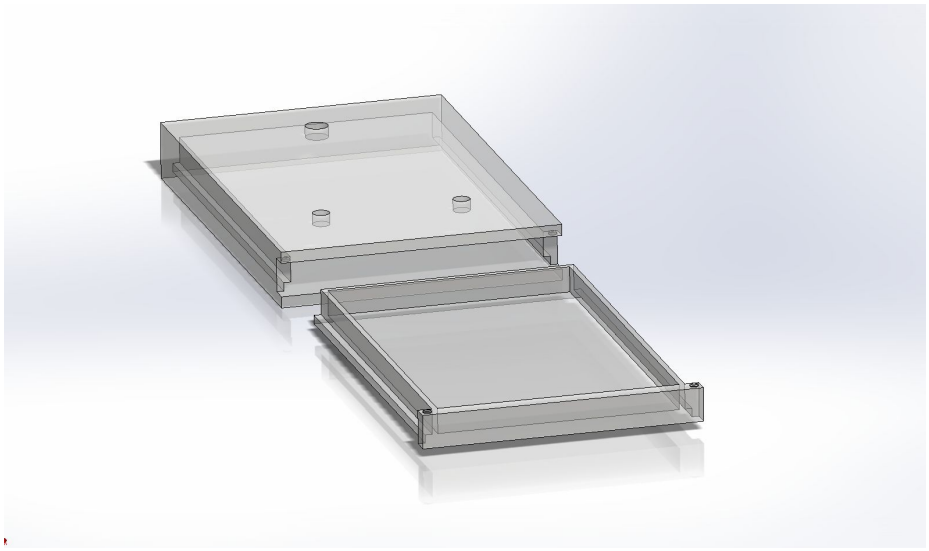


This design contains a lid and a base part with an overall dimension of 68mm*44mm*6mm. The base part has a 3mm deep camber inside the base and 0.75 mm deep continuous grooves on the sides. The lid part has 1mm continuous extrusions that can fit into the groove, sealing the chamber while leaving space for open it. Three pores are located at the lid: the larger one is for the input of the plant seed and two smaller ones are inlets for different bacteria. All the structures

are made of PDMS, which is gas permeable and transparent enough to grow the plant and observe the plant roots.

Design 2: Match Box:

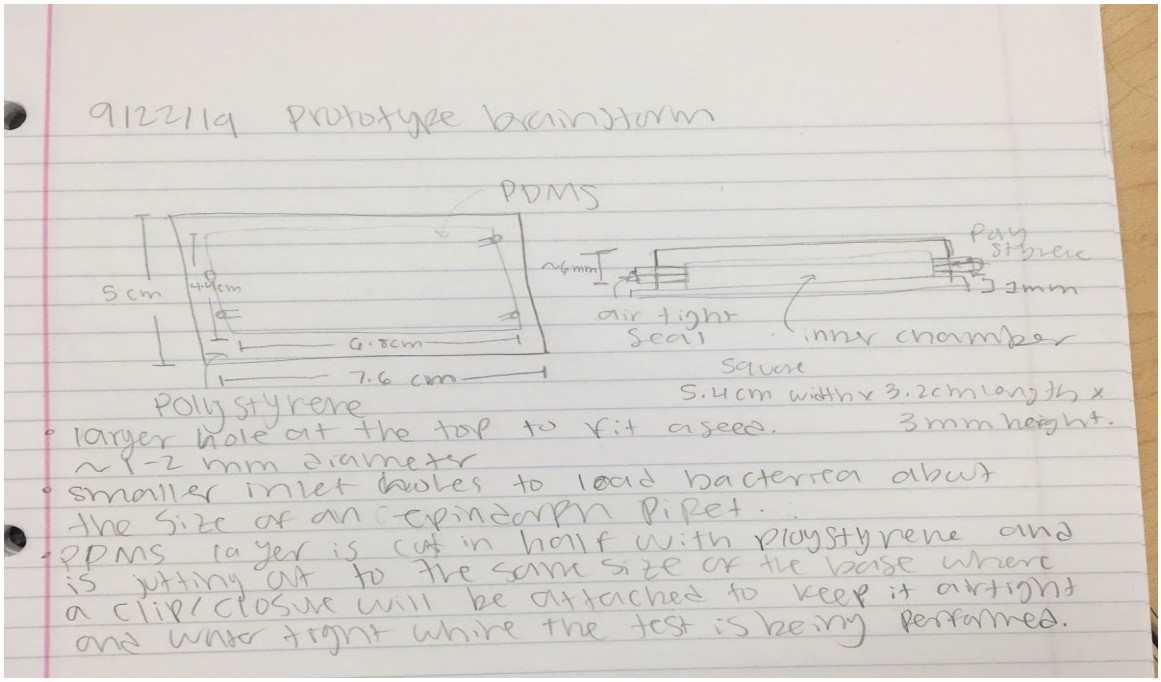




This design contains two parts. The first part is the main frame, and the second part is the platform. The material for the main frame will be PDMS, which is biocompatible, oxygen preamble, and highly transparent. Its size is 76mm x 50mm x 10mm. The size of the device

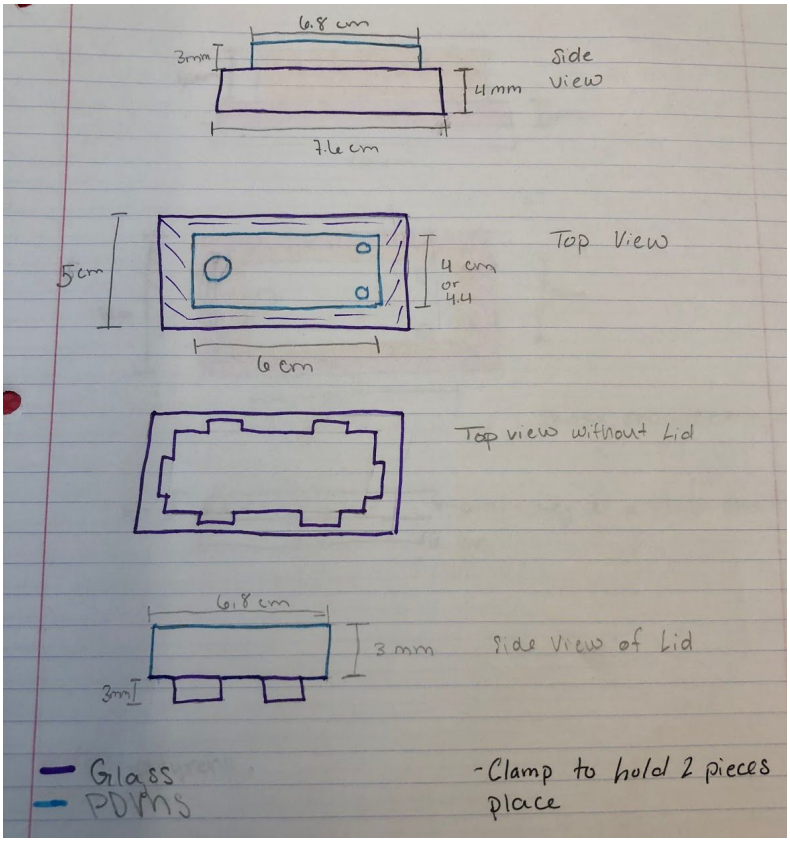
allows easy observation under microscope. On the top surface of the main frame there are three holes. The large hole has a diameter of 4mm, which is the inlet hole for seed settling and seed growth. The two small holes each has a diameter of 2mm. These two holes are the outlet holes for air flow and loading of bacteria into the device. The fixed positions of the outlet holes allow the researcher to load bacteria at fixed locations, which help keep the positions of bacteria for each experiment constantly and eliminate potential unexpected and uncertain variables. In the middle of the main frame, a chamber is designed to make sure that the platform can slide into the main frame and assemble to become the complete form of Match Box. The chamber is 70mm in depth. The height of the cavity is 6mm, which enables sufficient room for the growth of seed root, media, bacteria and sand. For the platform, the material for the slide in the middle will be 1.5mm glass slide. The material for other structure of polystyrene. The purposes of using different materials is that the glass slide has high transparency to enable clear microscopy and that the polystyrene can be more easily fabricated into detailed and complicated structures via milling than glass. The surrounding walls ensure leakproof and containment. The upper surface of the glass slide will be treated with a thin layer of PDMS for better biocompatibility. The Match Box can ease the loading process, culturing and microscopy to a large extent.

Design 3: Sealed Jar:



The design has a glass slide like bottom to allow for imaging from a microscope, the layer is about 1mm thick. Then there is a PDMS layer on top of the class slide that is about 2-3mm thick with a rectangular cutout making the chamber to where the experiment will take place, then there are two glass slides that match the cutout shape, but are flush with bottom glass slide to allow for clips to seal the device together. On the top there is another layer of PDMS that will enclose the whole chamber. There is one big hole about 2mm in diameter to allow for the plantation of a seed. Then there is 1mm diameter holes at the bottom and at the top to allow for the addition of bacteria, it is important that the bacteria be loaded through the smaller holes so that the location is standardized through all tests.

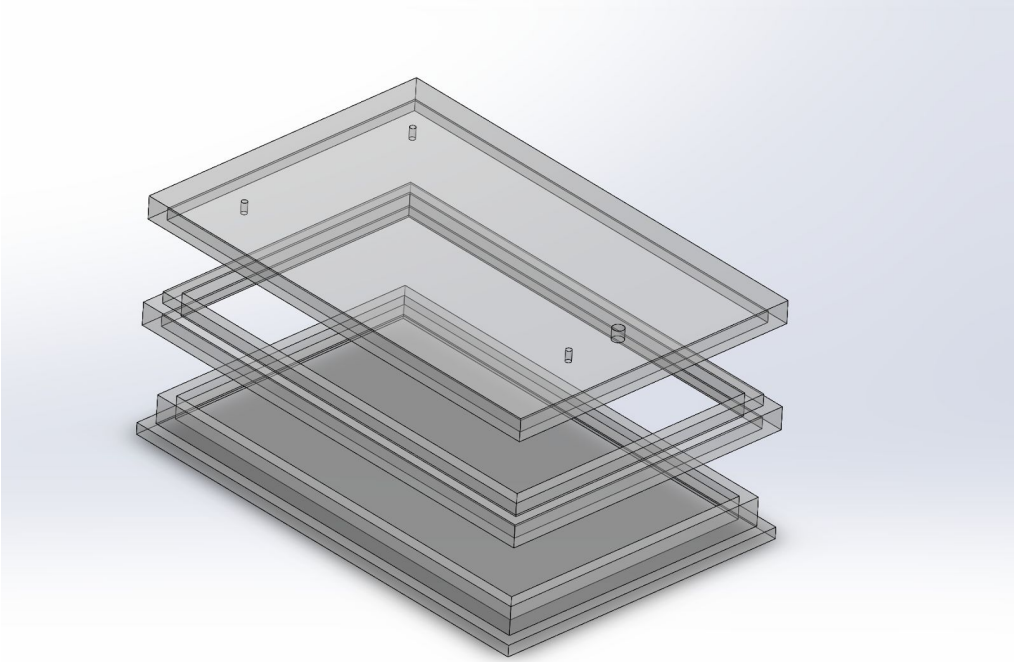
Design 4: Puzzle Piece



This design contains two parts to make it easy to load and unload material as well as image the bacteria and sterilize after use. The bottom piece is made of glass to allow for microscopy and is 5cm by 7.6cm, the same measurements as the prototype already created by the Handelsman Lab. This allows it to easily fit on the microscope platform. The glass piece is 4mm thick and the chamber is cut out into the glass 3mm deep, there is only 1mm between the chamber and the microscope which allows for high quality imaging. On the walls of the chamber are cutouts, two on each side and one on each end, which will be roughly 1mm in width and 1 cm in length.The lid or top of the device will be made from PDMS that is 6.8cm long, 4 cm wide and 3 mm tall. On the bottom on the PDMS will be a very thin layer of glass with teeth that exactly fit the grooves in the sides of the chamber. The idea is that the lid will slide into the chamber and have

a very tight fit, therefore closing and sealing the chamber. This design scored well because of simplicity and ease to manufacture.

Design 5: Modular



This Modular design is composed of three parts, including a top cover with holes for loading, a middle optional layer for increasing the chamber volume, and a bottom layer for holding bacteria, root, liquid medium, and sand. The top cover has one hole for holding seed and three smaller holes for either loading bacteria or assisting airflow. The bottom layer is designed to be shallower so that root of the plant can be pushed against the bottom piece as close as possible and the middle optional layer can be put in between the other two layers to increase the chamber capacity by increasing the height if required. The bottom piece is designed to be made of very transparent material, either glass or PDMS. The top cover and the optional layer can be made of polystyrene due to its biologically inert attribute.