

# Automated and Incubated Microplate System (AIMS)

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## Abstract

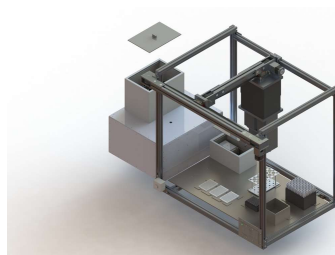
The Automated and Incubated Microplate (AIM) System is a microbioreactor which addresses the need for a comprehensive, user-independent incubation system. The AIM system can monitor the optical density and fluorescent intensity of culturing samples in well plates or sample tubes while regulating the gaseous environments, light intensity, temperature range, and liquid levels of the incubating media. The novelty of this device lies in its combination of the disparate capabilities of multiple pre-existing devices in a stand-alone manner that fits on laboratory benchtops while adding the ability to culture at extremophilic temperatures. The device is structured around an automated pipette and gripper system which prepares well plates and transports them to incubating, shaking, and analyzing environments. The device is designed to provide long-incubation, user-supplemented support for conical tube cultures. The assembly is facilitated by modularized aluminum framing and removable structures allowing for reliable sanitation for the culturing device. The modularized design also complements ease of assembly and accessibility for various laboratory spaces. Our team recognizes the challenges and limitations of creating a comprehensive device by establishing a Hedgehog Concept for the design: to create the most robust microbioreactor, maximize the automation of the culturing routines for microplates. In this, we recognize our passion for and expertise in controls engineering, developing an autonomous system that requires little user-involvement allowing researchers to allocate their time more efficiently.

## Product Functionality

Our emphasis was creating a robust semi-autonomous microbioreactor. The liquid handling subsystem aids in creating more autonomy by incorporating a gripper mechanism which can open and close to release and grab items, in addition, a stepper motor is used to rotate the arm for wider range of mobility. The gripper is also able to transport well plates and conical tubes within the entire system. The liquid handling subsystem uses automatic off-the-shelf Opentrons pipettes to fulfill the customer needs of dispensing volumes as low as 1 microliter up to 20,000 microliters. With x, y and z control the pipettes and gripper can be moved conjunctly around the system to allow for as minimum user interaction as possible. The environmental subsystem incorporates shakers and incubation control separately for conical tubes and well plates. The microplate system consists of controlling the shaking and the temperature of the well plates. The conical tube system uses temperature control sleeves to control the temperature of the system, this is then placed on top of the general platform shaker. There are two monitoring systems capable of measuring OD and FI independently for the microplates and conical tubes, respectively.

## CAD Models

Full Assembly



Liquid Handling System



Sleeve Assembly



The 3-axis control is responsible for moving the liquid handling system (the pipettes and gripper arm) inside the system. The x and y control uses stepper motors that rotate a timing belt which allows for movement of the pipettes and gripper. In addition, there's a carriage and rail system that aid in controlling the linear motion. The z-axis movement of the gripper and pipette is controlled using a linear actuator which lowers and raises a maximum of 8 inches in length.

The sleeve assembly consists of an aluminum sleeve which is temperature controlled by a Peltier module. There are two slots on each side of the tube holder for an LED and photodiode to be able to measure the OD and FI of conical tube samples.

Microplate Environmental System



The microplate environmental system consists of a BioShake Q1 shaker which can control the incubation temperature and shaking of a microplate. The chamber has holes in the side of the chamber (not shown) that allows for the connection of press fit tubes for the connection of pressure fit tubes for gas control. The shaker has connecting ducts to allow for proper ventilation and there are fins surrounding the entire system to increase the rate of heat transfer.

Conical Tube Environmental System



The conical tube environmental system consists of the previously shown sleeve assemblies in two sizes. These sleeve assemblies sit atop a circuit board which is attached to an aluminum base. The tube system is situated on top of a standard OTS shaker. Similar to the microplate system, there are fins to increase the rate of heat transfer.

## General Cost

General Cost	
Type	Cost
OTS Parts	\$12,875
Raw Materials	\$2,150
Manufacturing Labor	\$250
Energy Consumption	\$50
Assembly Labor	\$100
<b>Total:</b>	<b>\$15,425</b>

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