



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Benjamin C. Liu	Project Number S0516
Project Title A Fully-Integrated Lab-On-A-Chip Device for RNA Sample Preparation, Amplification, and Detection for Disease Diagnostics	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals RNA analysis requires multiple lab processes and manual handling that is tedious, expensive, and susceptible to cross-contamination. The goal of this project is to develop a fully integrated microfluidic device and a battery-powered, portable instrument that can perform RNA sample preparation, amplification, and detection for infectious disease diagnostics.</p> <p>Methods/Materials Development of individual technologies includes: 1) An electrolysis-based micropump was tested using a power supply, NaCl solution, and paper clips. 2) Acoustic micromixing was tested with a plastic chamber consisting of interior and side air pockets. Design elements were studied relative to micromixing rates for optimization of sample preparation. 3) Blisters were used to store reagent on-board. 4) A battery-powered portable instrument was designed using PCB-controlled motors for the mechanical operation of the device. An integrated microfluidic device was developed and tested on human urine samples for the detection of Mycoplasma Genitalium (MG).</p> <p>Results The acoustic micromixing reduced normal mixing times from 6-8 hours to 4-5 seconds. The electrochemical micropump generated H₂ gas for liquid pumping, in which the relationship between flow rate and DC current was studied. Reagent-storing blisters simplified cartridge design and prevented cross-contamination, acting as mixers, valves, and pumps. The mechanical fixture worked in compatibility with the battery-powered portable instrument for mechanical operation of the device. The device performed biological sample-to-answer analysis of real human urine samples and produced diagnostic results comparable to those of current technologies.</p> <p>Conclusions/Discussion This is the first demonstration of lab-on-a-chip technology for RNA sample preparation, isothermal amplification, and detection. Producing results on the detection of MG comparable to modern day diagnostic technologies, the device yields high potential in diagnosing thousands of other RNA-based diseases. The battery-powered portable instrument demonstrates the device's potential on handheld infectious disease diagnostics.</p>	
Summary Statement My project is about the development of a portable device that integrates all lab functions for RNA infectious disease diagnostics.	
Help Received Dr. L. Hui gave me advice on improving my research. RD Bio gave me access to their lab equipment to conduct research.	