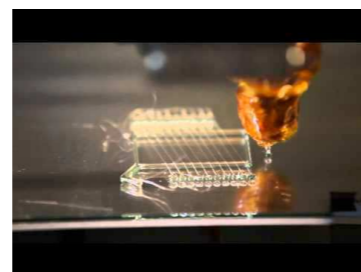
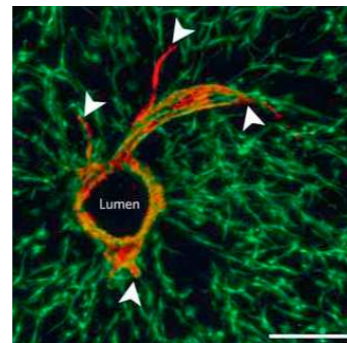
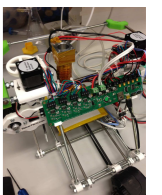
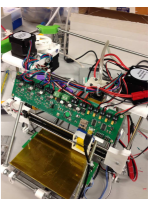
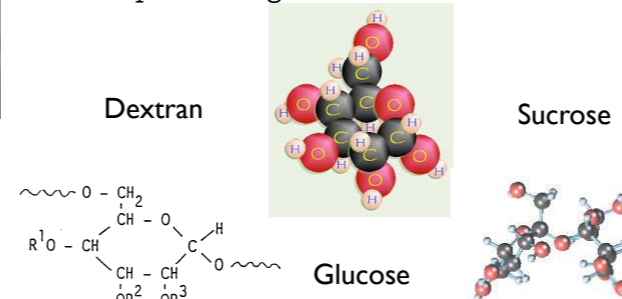


Many different materials have been researched for uses in both 3D printing and tissue engineering. Many of these are expensive or toxic. In the last decade, expensive 3D printers used primarily to make plastic models have morphed into affordable consumer grade machines with a multitude of different types of material available to print with. In 2008 the Makerbot Frostruder was the first widely available paste extruder kit on the market. it used a plastic syringe and air pressure to extrude frosting and other pastes. In 2012 Jordan Miller lead a team at the University of Pennsylvanian that created a new type of extruder. This printhead, called the BaricUDA Extruder used heat and pressure to extrude many different pastes and glasses. They developed techniques using this methodology that would allow researchers to create vascular networks in vitro. These channels in the agarose help prevent necrotic cores from developing in cultures by maximizing the number of cells exposed to nutrient fluid (Blood). The cells then form a lumen (blood vessel wall) and once it is solidified enough, the wall is sturdy enough to act as a synthetic blood vessel. Our team contacted University of Pennsylvania online for suggestions and they told us "(Be) careful with a glass syringe under air pressure. we are designing an all metal one now to be more safe." Apparently the glass syringe presented a significant hazard. One that we have now corrected. Our customized tool the CarmAL Extruder can operate safely at temperatures of over 170 C and pressures higher than 80 PSI.



We began by ordering and constructing the 3D printer known as the Rep Rap Huxley. Once the construction was completed, we calibrated the printer and began to test the printer by printing pieces made from P.L.A. and A.B.S. plastics. After a few successful prints, we proceeded with the modifications that the printer needs in order to print sugar. We consulted my father, whom is a machinist, to build a extruder tip out of aluminum using a CAD design from Devon Bane. The attempt was a success and now we have our own custom design of a metal extruder tip to print the sugar. We prepared a solution of 25g Glucose 53g Sucrose 10g Dextran and 50 ml reverse osmosis water. After all the modifications were completed we printed sugar test for the first time.



Miller, Jordan S. "Rapid casting of patterned vascular networks for perfusable engineered three-dimensional tissues." *Nature Materials* 11 (2012). Web. 4 Sept. 2013.

Xu, Tao, Weixin Zhao, Jian-Ming Zhu, Mohammas Z. Albanna, and James J. Yoo. "Complex Heterogeneous tissue constructs containing multiple cell types prepared by inkjet printing technology." *Biomaterials* (2012). Print.

