



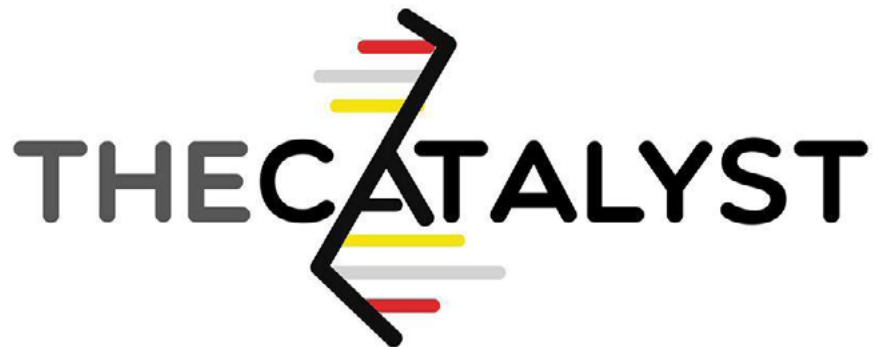
THE CATALYST

**University of Maryland's Undergraduate
Bioengineering Research Journal**

Issue No. 4 - Winter 2016

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Want to get published in the next issue?



The Catalyst is UMD's undergraduate bioengineering research journal. We are looking to publish a variety of related undergraduate research with our fifth issue coming this Summer 2016! If you are an undergraduate student working on publishable research related to biomedical engineering and biotechnology, you are qualified to participate. Contact us via email or submit your research abstract through the link provided below. Feel free to check out our previous issues as well.

No research experience?

You can still take part in *The Catalyst*'s News Updates sections, which showcases topics such as recent BioE student events. Email us if you are interested in contributing.



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Letter From the Editor

Dear Catalyst readers,

It is hard to believe that I, along with some other bioengineering students, helped start *The Catalyst* two years ago. This is our fourth issue, and wow, we have come a long way from where we used to be. We were founded in order to get students interested in undergraduate research, as we all understand the indispensable skills that are gained from the experience. That mission has not changed in the past couple issues, but the way that we present the information has. We seek to make *The Catalyst* more readable with each issue and to increase accessibility to high school students.

We have decided to make a big change to our content this semester. In the past, we published full-length research articles from undergraduate researchers. In order to present interesting student research stories in a more succinct manner, we are trying out research synopses this issue. These research synopses are meant to maintain some of the technical rigor of a full paper, but also convey personal student experiences in research. We hope that these are more powerful and speak to more students. As such, we want your feedback. Let us know what you think via email (thecatalystumd@gmail.com) about the research synopses or suggest that we revert back to a full-length paper in each issue. The choice is yours.

Although the research synopses represent the meat of this issue, we also present a couple other interesting stories. Learn what Bioengineering undergraduates did this summer. From setting up a hospital on a reservation to NIH to Medimmune, you can find it all in this issue. Next, catch up on the latest news about iGem's inexpensive PCR machine built out of a hair dryer! You can also read about the BMES-UMD Institute for In Vitro Sciences (IIVS) tour and the founding of the AEMB Biomedical Engineering Honor Society chapter within our department. Finally, get a personal interview with one of the newest Bioengineering faculty, Dr. Scarcelli. Student interviewers ask him the questions, so see what he has to say about running a lab and teaching.

I would be remiss not to mentioning all the amazing supporters that helped us through our Launch UMD crowdfunding campaign. With this incredible support, we were able to print hard copy editions of some of our previous issues to place in the bioengineering student lounge. We will also be printing hard copies of this issue to distribute to prospective and current students to further our mission of galvanizing interest in undergraduate research. We also hope to use these funds for undergraduate research outreach and to host a workshop this upcoming semester to teach students about getting into campus labs.

Thank you for taking the time to read our newest issue, and as the editorial board, we hope that we can get you as excited about undergraduate bioengineering and biotechnology research as we are. The fantastic work of the editorial board comes out in this issue, and I cannot thank them enough for their contributions to keep *The Catalyst* alive and ever-expanding. We hope that you enjoy this issue as much as we enjoy putting it together for you, our dedicated reader.

Enjoy our issue,

Adam Berger
The Catalyst Editor-in-Chief



Thank you for your contribution!

Our Launch UMD campaign was a success with the help of our donors listed below. We cannot thank you enough for your generosity. The Catalyst will now be able to print hard copies of its issues and assist undergraduates in discovering more about research opportunities at the University of Maryland.



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Chuck Greenberg
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Jan Spohn
& 10 Anonymous Donors

AEMB: UMD's Chapter of the National Biomedical Engineering Honor Society

By Bryan Pinsky, Staff Contributor and Meghna Ramaswamy, Guest Contributor

First established nationally in 1979, Alpha Eta Mu Beta was formed as a way to recognize and encourage academic excellence in the field of Biomedical Engineering and Bioengineering. This year, through the efforts of the department – including students, staff, and faculty as founding members – the national conference recognized the chapter at the University of Maryland, College Park. The UMD Chapter received its charter in-person at the AEMB Reception during the annual Biomedical Engineering Society (BMES) conference this month in Tampa, Florida. Nationally, AEMB serves to recognize students in the field of bioengineering, and moreover, to further the community by enhancing student-faculty relationships and promoting interest in the field of bioengineering.

The University of Maryland is not lacking talented students, especially within the bioengineering community. These students hold a genuine passion to influence the larger community. AEMB will capitalize on this pool of talent, providing a platform for passionate, motivated students to utilize the tools provided to them. At present, students in collaboration with Dr. Chung and Dr. White are leading efforts to introduce tutoring programs specific to bioengineering classes. The tutoring programs will focus on providing another method for students to better understand the materials. We believe that there are not many alternative methods for undergraduates to ask other students questions on the class material, and we are looking forward to providing a service that will make the academic experience in our department more enjoyable. AEMB also believes this will give underclassmen a chance to connect with upperclassmen. With connecting the community in mind, our organization will also be at the forefront of peer mentoring through BIOE221 - a course designed to help sophomore bioengineering students navigate the department and the opportunities available within it. BIOE221 will provide an increased exposure to the bioengineering course curriculum which is currently lacking in the first two years as an undergraduate student. Our perspective on the addition of this course is that it will help underclassmen have a more comprehensive understanding about “what exactly a bioengineering degree means” at a point in their academic career where they might be unsure about whether they want to even pursue bioengineering. We intend to keep these services sustainable in the long-term by making the programs a foundation for membership activity in AEMB.

Although we intend to provide many quality academic services to the general bioengineering population, we look forward to other activities within our society. We will partner with other organizations to improve access to student design competitions, service activities, and other various community activities. Due to academic cutoffs and the hard work our members will be putting in for our academic services, we will reward members through social events, exposure to a valuable network of bioengineers, and insight from guest speakers. We hope that these activities will make the AEMB membership perspective one of wonderful experience and benefits other than only being a resume builder.

UNIVERSITY OF MARYLAND CHAPTER OF
ALPHA ETA MU BETA
NATIONAL BIOMEDICAL ENGINEERING HONOR SOCIETY

UMaryland iGEM Competes in 2015 iGEM Jamboree

By Kevin Pineault, Research Chair, Nathan Barber, Guest Contributor, and Aditya Biswas, Guest Contributor

iGEM (International Genetic Engineered Machine) is an international synthetic biology competition which draws research teams from around the world to compete and share their novel ideas in synthetic biology. This year, The 5 day competition was from Sept. 24th to Sept. 28th at the Hynes Convention Center in Boston, MA. The UMaryland team that competed consisted of 15 undergraduates, 4 graduate advisors, and 3 faculty advisors. In addition to securing another gold medal in only their second year of competing, the team was nominated as one of 5 teams for the best project in their track. With their project, they were able to successfully demonstrate a synthetic biology based alternative to antibiotics for plasmid maintenance and created a functioning thermocycler for only \$60.



UMaryland iGEM team members and advisors finalize their presentation.

Alternative methods of plasmid maintenance and PCR amplification accelerate the construction of new biodesigns, reduce cost, and avoid environmental hazards. Plasmids are typically maintained in cells by encoding enzymes that hydrolyze or otherwise detoxify antibiotics added to the medium. However, this process carries an inherent risk for spreading antibiotic resistance to native bacterial populations through lateral gene transfer. The Hok-Sok toxin-antitoxin system, a natural internal maintenance cassette relying on internal mRNA silencing, presents an alternative to common antibiotic-based methods since it does not rely on exogenous drugs. The team isolated this gene sequence and successfully cloned it into *E. coli* strains. They were then able to demonstrate that it was comparable to using modern antibiotics through a series of laboratory experiments.

Polymerase chain reaction, or PCR is an essential and common laboratory procedure used to amplify DNA through the use of hardware known as a thermocycler. As the name suggests the device is able to cycle through various temperatures and hold them for specific lengths of time. These machines are not cheap, ranging in price from a couple thousand dollars to tens of thousands for real time PCR units. Our focus was to reduce the price of these units and enable the general public to construct one of these machines. The machine was constructed out of a hairdryer—its heating coils were used to reach the needed temperatures, and the fan was utilized to convect hot air onto the heating plate—and a soda can. With this setup our team reduced the price of a thermocycler one thousand fold down to approximately 60 dollars using easily accessible parts.

Meet the Faculty: Dr. Giuliano Scarcelli

By Bryan Pinsky, Staff Contributor

Get to know Dr. Scarcelli in this exclusive interview. He taught BIOE371 in Fall 2015, and is teaching BIOE489I: Special Topics in Bioengineering - Optical Microscopy in Spring 2016. He runs the Optics Bio-tech Laboratory at UMD.



Q: What is your background?

GS: My studies have focused on physics with a PhD in quantum optics and my research being focused on biomedical optics.

Q: What type of work do you perform in your lab?

GS: We are currently working on setting up microscopes to focus on structures by characterizing their stiffness. Once, we have everything set up we can focus our attention on starting clinical trials.

Q: What made you want to come to the University of Maryland?

GS: UMD had been a dream school of mine. My undergraduate advisor in Italy was a College Park alumnus. I then obtained a European fellowship at UMBC to obtain my PhD. My experience with my advisor and the fellowship truly built an increased appreciation for the University of Maryland in College Park.

Q: What is it like starting up your own lab?

GS: It's been slow for the most part. We are spending a lot of time setting up an optical table, however there have been delays due to the weather. Although, we have been resourceful by using chemical benches. We spent quite a bit of time to find this new solution that is working.

Q: What is your approach to research?

GS: My research is driven to build advancements towards innovative instrumentation and medicine so happens to be a great field for application of optics.

Q: What advice do you have for students looking to get a PhD and become professors themselves one day?

GS: I would say for now that there are four things you should focus on for now. Maintaining a high GPA, win fellowships, do research, and develop a strong relationship with professors for your recommendations. If you do those four things you should be set for any PhD program.

Q: What are the daily activities of a UMD Bioengineering professor?

GS: For right now, I am focusing on writing papers and grants for my lab. I also have been spending a good amount of time in the lab to help set up the optical tables.

Q: Do you currently have any openings in your lab?

GS: I am not actively looking for new members; however, for the right person I can make room to join my team.

BMES-UMD Takes a Tour of IIVS

By Adam Berger, Editor-in-Chief

On November 21st, 10 BMES-UMD students traveled to the Institute for in vitro Sciences (IIVS) in Gaithersburg to learn about *in vitro* toxicology. The students learned that traditionally, toxicology research for the thousands of chemicals that go into our everyday products are performed on animals. In order to accomplish the three R's of animal research (reduce, refine, and replace), IIVS is advancing the use of novel *in vitro* assays to perform toxicology work. Students learned



about these new tech-

nologies through demonstrations and even got some hands-on experiences. Students learned about one assay that uses high-performance liquid chromatography to detect the covalent binding of the allergen to cysteine and lysine residues. This is often a first step in the process of determining whether or not a certain chemical will be a sensitizer or irritant. Students also learned how a flow cytometer works and how to perform gating on a cell population. The students watched a demo of the separation of various cells from whole blood. IIVS normally uses flow cytometry to look for cell surface markers of dendritic cells, which can signal an immune response to a substance. Finally, students performed a hands on dissection of bovine eyeballs. Although this is an *ex vivo* testing method, the eyes are a byproduct of the food industry and therefore not considered inhumane. The students worked to extract the cornea from the rest of the eye and place it in containers to do chemical testing on. IIVS uses this bovine corneal assay to learn about the effects that various chemical irritants on the eye. During lunch, the IIVS staff and BMES members had a roundtable discussion about career advice.

Overall, the students all had a great time and learned a lot about the big field of toxicology, which we all depend on to provide safe household products, cosmetics, etc. BMES member and VP of Service, Hailey Jones, said "It was awesome learning about how we can develop *in vitro* methods to test materials and still retain the validity of the results while saving animal lives. Dissecting cow eyeballs and being able to recognize the anatomy I've learned about and seeing how it's all put together was so cool!" BMES-UMD hopes to make this a yearly tour due to the great feedback from students!



BIOE SUMMER INTERNSHIPS

Bioreactor Research at Medimmune

By Aakash Patel, Guest Contributor

This past summer, I had one of the best internship experiences an undergraduate student can ask for. I interned at MedImmune, a local pharmaceutical company that produces the ever popular Flu-Mist®. The experience I had was very unique because it allowed me to make decisions on what I want to do after I graduate. My internship started like any internship with an orientation program that helped all the 120+ interns get acquainted with the company and figure out how to navigate the massive campus. When I met my manager/mentor, we skipped the usual awkward getting to know you step and went directly into the lab.

As we walked into the lab, my mentor explained how he was going to treat me like a full employee and basically let me make my own decisions throughout the entire summer. As we entered the lab, he quickly explained how the lab works and introduced me to the important people in the lab. Then we headed directly to the biosafety cabinets where he sat down and started to do cell splits. He quickly explained to me what he was doing and showed me how to conduct a cell split. The rest of my day consisted of me following my mentor around the lab and observing what he was doing, whether it was conducting cell splits, maintaining the bioreactors, or feeding his cells. My first day lasted approximately 10 hours and it basically set the pace for the rest of my summer.

For the next few days in the lab, my manager would just walk me through every task that he would do on a routine, including setting up, tearing down bioreactors and decontaminating bioreactors infected with bacteria. During my second week, my manager gave me a project, which was to optimize a scale-down bioreactor model that would allow his department to better predict what would happen in the production scale (2000 and 15000L) bioreactors. He helped me set up and run my first experiment. However, by the third week, my manager stopped coming into the lab and trusted me to run my experiment. He would occasionally check up on me every couple of days and see how my experiment was running but otherwise it was my responsibility to run the experiments and to analyze the data.



Aakash in his lab at Medimmune.

During my second month, my manager was so satisfied with my progress that he started giving me side projects that would mess up MedImmune's drug pipeline if left incomplete. As I continued to quickly finish off these projects, more and more people in the lab would trust me with their projects and asked me to help them out. As this continued, I started working close to 50 hours a week including weekends. Most of the work I was doing were not simple intern tasks (such as conducting cell splits or serial dilutions) but rather were complicated tasks that senior scientists were conducting on a daily basis such as planning experiments, setting up and running multiple bioreactors, and conducting optimization assays. In addition, I was also able to teach a few of the scientists on how to

conduct a new respiration assay and showed them how to optimize that assay for their specific cell lines.

Even though I was working close to nine to ten hours a day, I still found time to hang out with the other interns and see what they were doing. Throughout MedImmune, there were several hidden game rooms where the interns and scientists would relax and play Mario Kart, pool, or ping-pong. I even made a few friends with whom I took a vacation with and still keep in touch with. Furthermore, many of the interns would hang out with each other every Friday afternoon during happy hour, where a specific MedImmune department would throw a theme party.

During the last week, all the interns presented their research at a company-wide poster presentation. Everyone presented their posters in front of the entire company and gave a presentation to their entire department. In addition to presenting to my department, I also had the opportunity to present my findings to MedImmune's cell culture department in the United Kingdom.

During my internship I was able to experience what my life would be like if I was a full time scientist in charge of conducting experiments that would impact the course of a lifesaving drug. Even though there were a few weeks where all I did was work 10 hour days and come home and sleep I would not trade it for any other experience. This summer internship allowed me to make my decision on becoming a scientist rather than going to medical school.



Research at the National Institutes of Health with BESIP

By Nadia Abutaleb, Guest Contributor

This past summer, I had the incredible experience of completing the Bioengineering Summer Internship Program (BESIP) at the National Institutes of Health (NIH). During this exciting 10-week internship, 16 rising bioengineering seniors from across the nation get to live together in Bethesda, participate in cutting-edge research with world-class scientists, and attend numerous career planning lectures that are offered daily at the NIH. I would highly recommend this internship to anyone interested in biomedical research looking to gain experience in the bioengineering field or just wanting to have a great summer learning something new.

I first heard about BESIP when I was looking at the NIH intramural training website in my sophomore year. BESIP caught my eye due to its focus on bioengineering, which seemed more personalized in nature

than the popular Summer Internship Program and a smaller size. Since BESIP is only offered to rising seniors, I kept it in the back of my mind until the second semester of my junior year. By then, I had been working in Dr. Bentley's lab in the bioengineering department for almost 6 months and was planning on continuing through the rest of the semester and into the summer. Knowing that only 16 students get selected to participate in BESIP, I applied anyway, thinking I had no chance of getting in. To my surprise, I was informed that I'd been accepted to the program at the end of February. Now I had a decision to make: stay in my lab with a mentor who I knew I enjoyed working with and could learn from, or take a chance and go to the NIH? After conferring with many people, including my PI and the 16 interns from last year, I decided to take the opportunity to work at the NIH, knowing that I could come back to my lab in the fall. Though I was hesitant then, I know now that I absolutely made the right decision.

All 16 interns in BESIP were housed in Bethesda by the White Flint Metro Station. Regardless of the research, living with these people made the summer an incredible experience! We went to movies and concerts, explored DC (even a native like me can be a tourist!), took turns cooking dinner for each other, and all around had a great time. Being in such a small program and living together really set BESIP apart and made the whole experience much more enjoyable and meaningful. The BESIP director Dr. Bob Lutz also cares immensely for his interns and makes sure to foster community; he would check on us regularly to ensure that our principal investigators are having us engage in meaningful, independent research.

Being in such a small program and living together really set BESIP apart and made the whole experience much more enjoyable and meaningful.

Okay, so we all know that it's great living with 16 college students from around the country, but what was the research like? I'm happy to report that the research was equally as enjoyable as the company. Many times with big research institutions, interns end up being dishwashers or lab techs. BESIP, on the other hand, requires every intern to work on his/her own research project that is determined before the start of the internship. At the end of the summer, every student presents his/her project to everyone's peers, PIs, and lab-mates in both poster and oral form. Furthermore, Dr. Lutz visits every student in each lab throughout the summer to make sure that everything is running smoothly and everyone is enjoying the experience. This summer, I worked on optimizing the specific and efficient capture of immunostained beta cells in mouse pancreas tissue using a new prototype microdissection device developed at the NIH. Not only did I get to learn how to use the device from its inventors, but I got to work on a large collaboration across five different NIH institutes. I gained experience working with medical devices, developing image analysis techniques, and working with a large team of investigators.

BESIP not only spiced up my resume, but more importantly, it increased my research experience. It added breadth to my knowledge of the bioengineering field, but it was also a really fun experience. Living with the other interns made the summer truly special and Dr. Lutz made sure that we always felt taken care of. I still talk to my friends from this summer and I anticipate those relationships lasting a really long time. I'm also still working at the NIH part-time as a student fellow, as my mentors asked me to continue on my project past the end of the internship. Overall, I would highly recommend BESIP to any juniors looking for an internship experience next summer. You'll learn a ton, have a lot of fun, and build relationships that will last a lifetime. And to make things even sweeter, you might get a job out of it too!



Improving Healthcare in Reservation Hospitals

By Ashlyn Lee, Design Team

During back to school time, all the professors, TAs, and student organizations are asking the same question during icebreakers: “What did you do over the summer?” Most people talk about their industry or research internships. Then it’s my turn. “Hi, my name is Ashlyn, I’m a junior studying bio-engineering, and this summer I helped open a hospital in Arizona.” It’s the easiest way to sum up my summer in two seconds, but I’m not exaggerating. I helped establish a hospital on a reservation in Arizona. This was a historic milestone in the history of the San Carlos Apache Reservation, and I am grateful to have had the opportunity to be a part of it.

I was selected for the Junior Commissioned Officer Student Training and Extern Program (JRCOSTEP) by the Indian Health Service’s (IHS) Office of Environmental Health and Engineering, Phoenix Area Office. I worked mainly with Mark Wilner, the clinical engineer overseeing all ten service units in Phoenix Area, which provide healthcare services to about 140,000 American Indian/Alaska Natives in Arizona, Utah, and Nevada. This summer, the San Carlos Apache Health Care Center on the San Carlos Apache Reservation (~2 hours from Phoenix) was scheduled to open, which meant all resources were being diverted to make sure the facility could open full services by July 13.

I never could have imagined all the biomedical resources that were shipped in to supply the hospital with the necessary equipment we take for granted in medical care. Preparing to open a hospital in such a remote area in a matter of weeks was no easy feat, as I witnessed first-hand during daily Incident Command meetings led by Dr. Marie Russell of IHS. These meetings were personally significant in that Dr. Russell was a prime example of the opportunities for female leadership within the government. Her focus and dedication were the driving force for opening this hospital on time. During these meetings, dozens of issues were brought up that I never would have considered, revealing the broad scope of work involved in setting up a hospital, from bug infestations to the equipment to the IT infrastructure. My work with biomedical equipment was only a small, but necessary, part of it all.

The goal of my work in San Carlos was to establish an accurate inventory of all medical equipment in five buildings. While this did involve a copious amount of data entry and probably sounds boring and unimportant, there were many important implications behind this endeavor. IHS does not open hospitals or clinics very often, and the biomedical programs in existing facilities are relatively new and not always the most consistent. Inventory is just the beginning phase of any biomedical program, and we wanted to set a standard for future programs. Also, inventory is vital for patient safety and compliance with hospital accreditation requirements. Governing bodies that accredit hospitals for safety need detailed records to prove that the hospital in question is keeping track of its medical equipment. If a device is malfunctioning, up-to-date identification and location information is needed for repair. If a medical device manufacturing company issues a recall and a hospital lacks a proper inventory, this results in wasted hours attempting to verify that none of the hospital’s equipment will harm patients. In addition, training the staff for the new hospital’s operations was much smoother when



CT scanner at the San Carlos Apache Health Care Center, Radiology Department.

they knew exactly what equipment they had to work with. The radiology equipment in the dental department was most interesting to inventory - brand-new DigiDoc cameras were under lock and key because they weren't ready to be installed yet, and I learned how a technician actually sets up and tests the X-ray machines. A bioengineering background provided a basis of knowledge for understanding the role and function of the equipment I was inventorying, but I certainly learned a lot about hospitals that is not taught to burgeoning bioengineers.



Outside the San Carlos Apache Health Care Center in Peridot, AZ.

During my time in San Carlos, I was able to see the old hospital before its demolition and the new hospital in the stages before and after opening. The old hospital was a single run-down building that had been offering limited services to the San Carlos Apache since 1963. The new hospital was a major upgrade, with five buildings: the Main Hospital, Dental, Emergency Medical Services, Behavioral Health, and Public Health; however, there were still many challenges due to the remote area. Before opening, recording inventory was especially difficult due to lack of any communication signals. Internet connectivity was required to access the inventory system, but there was no WiFi, limited cellular reception, and initial problems getting access to the desktop computers installed throughout the hospital. So many biomedical technologies are so dependent on communication that I never would have expected these problems. Some staff had to use walkie-talkies, and we had to improvise methods of efficient data entry, which ranged from wheeling a cart with a laptop around to taking hundreds of pictures and entering in all the information at a later time.

After opening, I was able to truly appreciate the work I had been doing for weeks. The hospital transformed into a lively environment for people of all ages. I learned that the land the hospital was built on was to doubly serve as a social gathering area for the community. Some of the natives were there for medical services, some wanted a spot to relax inside after making the trek out, and others were simply curious. In the past, many patients had to be flown out to other facilities for treatment because the old hospital could not provide necessary care. Now, the hospital represents a greater degree of control over their healthcare. Even though the hospital only has 8 inpatient beds, it offers better medical technology than they've ever had before, with radiology devices for CT scans, MRI, and mammography, and advanced equipment in all departments, such as dental, outpatient, optometry, and labor/delivery. The hospital will also provide more jobs for the locals and set an example for other tribes to learn from. Opening the San Carlos Apache Health Care Center was an extraordinary learning experience for me, and I am proud to have made a small impact on a landmark point of history for the San Carlos Apache.

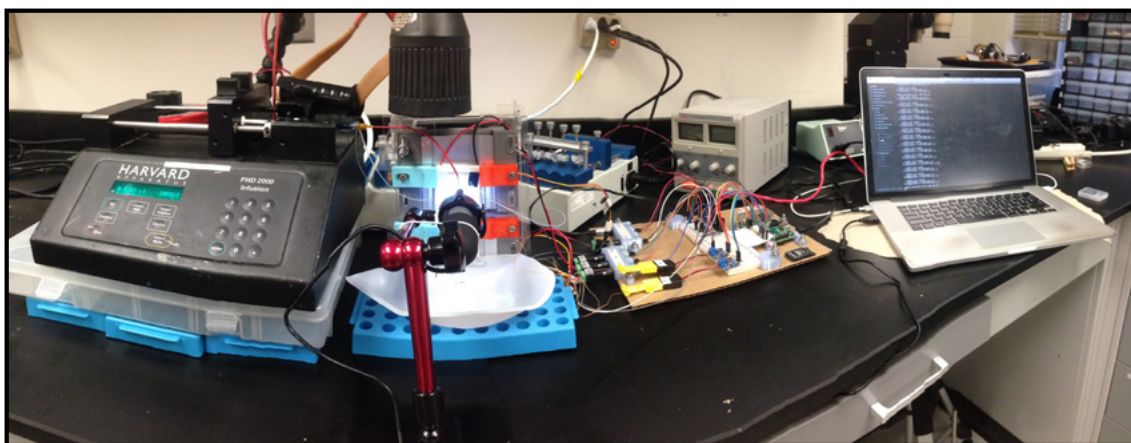
RESEARCH ARTICLES

Bringing the Heat: Melting Agarose Beads for Microfluidic Immunoassays

By Kyle King, Guest Contributor

I am an undergraduate researcher in the UMD MEMS and Microfluidics Lab (MML) run by Dr. Don DeVoe. Over the past year and a half, I have pioneered an agarose bead-based immunoassay for potential application for Ebola biomarker detection.

Quick and efficient disease diagnostics require innovative simplifications and innovative approaches. Current diagnostic tests are often performed by lab technicians and can take 12 to 24 hours to heed results. Swift and reliable results can influence treatment plans and avoid unnecessary follow-up appointments. I am developing a rapid, microfluidic technology that reduces complexity, operates at lower pressure, and offers a faster turnaround time. The final product is a tool that can be integrated into a sample preparation device to be used by a variety of audiences including primary care physicians and doctors in developing countries.



A glimpse of Kyle's lab: LMP agarose bead generator, syringe pumps, Raspberry Pi PID controller, and other components necessary for effective operation.

Rather than waiting for an analyte in a sample to interact with an activated surface, our solution involves an efficient matrix of activated low melting point (LMP) agarose beads. The large surface area results in little to no delays in diffusion time, allowing for rapid binding reactions and the identification of small concentrations of analyte. Quantifying the amount of analyte requires a specific technique to overcome the opaque nature of the capture matrix. Typically, an additional fluid would be introduced to reduce the effects of light scattering and improve optical clarity; however, the additional fluid must be very viscous, which leads to air bubbles, clogging, and increased device complexity. Instead, a matrix of LMP agarose beads can be melted to improve optical clarity. When melted, the beads create one conglomerate with fewer surfaces to scatter light.

Over the past year, I have created an innovative LMP agarose droplet generator, shown the optical improvement of melting, and demonstrated the detection of an analyte. I hope to prepare an article for publication in the spring, so I will be collecting data to demonstrate the lowest concentration detectable with the LMP agarose bead matrix, integrating a raspberry pi camera for analyte quantification, and potentially demonstrating a diagnostic test for Ebola. If you would like to learn more about the progress of my proj-

ect and see photos, please visit my website at <http://kyleking.me/microfluidics>.

My advice to Bioengineering undergraduates is to begin a research position with an apprenticeship alongside a graduate student conducting similar work. In my position, I was given my own project and worked predominantly independently; however, I often followed around the graduate students to learn their processes and thinking behind designing an experiment, which has helped develop my skills and progress my independent project. Additionally, don't be afraid to take the risk of emailing a professor you think is interesting. You have a unique position at a large research university to be part of something exciting.

A Journey Through Research

By Ariel Isser, Guest Contributor

During my senior year in high school, I came across a TED talk of Dr. Anthony Atala printing a human kidney onstage with a modified 3D printer. Witnessing this huge milestone in biomedical engineering, my passion for biomedical research was ignited. Realizing I didn't just want to sit on the sidelines, I did something comically bold that launched my journey into bioengineering research - I emailed every professor in the bioengineering department at University of Maryland, asking to work in their lab. Somehow my nerve paid off and I received a response from Professor Ben Shapiro in the Control of Miniaturized Systems group, inviting me to come in for a chat. Dr. Shapiro's group applies control theory in a variety of biological applications, most heavily for magnetic nanoparticle drug targeting. As part of the process, Dr. Shapiro hired me for that summer to develop a device that could map three-dimensional magnetic fields around magnets of variable dimensions.

After completion of that project, I returned to Dr. Shapiro's lab during my freshman and sophomore years to design a microfluidic device for high-throughput, in-vivo screening of the *Caenorhabditis elegans* (*C. Elegans*) nematode, a commonly used model organism. The advantage of this device over analogous high-throughput *in vitro* assays is its greater ability to predict the effects of drugs in humans. Consequently, it can help improve the accuracy and speed of drug discovery and screening. During my freshman year, I created a fabrication process for a polydimethylsiloxane (PDMS)-based device that could straighten the *C. elegans* using hydrodynamic focusing and trap them inside a region of interest by actuating a solenoid valve. In my sophomore year, I wrote software for the device in MATLAB. I implemented Kalman filtering and several image processing algorithms to track nematodes in real-time. I also helped develop edge-detection and energy minimization techniques to virtually straighten *C. elegans* images for morphological analysis. As proof of concept, I recorded some exciting footage of nematodes being trapped with the device for a grant proposal. The project is still ongoing and more work must still be done to properly sort nematodes based on chemical markers or physical characteristics.

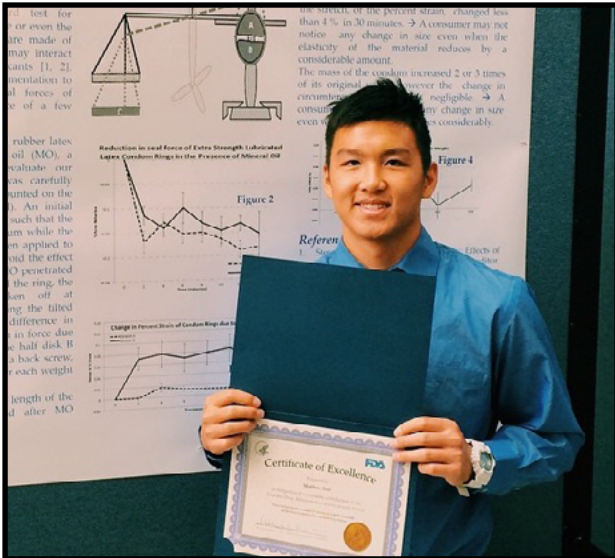
Since then, I have worked in several polymer science and biomaterials groups, on projects that have ranged from being entirely experimental to entirely computational. My personal advice for BIOE undergrads is never to be intimidated about working in a lab because of lack of knowledge or experience. Instead, embrace the opportunity to learn a lot, develop skills, and become self-sufficient. The amount of knowledge and experience I have gained from working on new projects that have required completely different skill sets rivals what I have learned through my coursework. More importantly, knowing that I have been able to tackle these sorts of obstacles in the past, I feel empowered to face whatever challenges lie ahead.



Research with the FDA: Biomaterials

By Matthew Din, Guest Contributor

I received an internship at the U.S. Food and Drug Administration (FDA) under Dr. Maureen Dreher to work on the mechanical testing and design of 3D printed, polymeric scaffolds. I received the offer through networking with my previous supervisor at the FDA in a different division during the previous summer. The aims of the lab were to conduct compression and torsion testing of 3D printed scaffolds made out of degradable polymers in order to observe the validity of each print. In addition, microCT imaging was utilized to create 3D images of the specimens while also allowing evaluation of print validity.



Matt Din with a certificate of excellency from the FDA.

The goals of my research are to gain immense experience in different aspects of bioengineering; this summer, the experience was extended to design and testing of the area of biomaterials and medical devices. It is important to experience work in this field because it allows me exposure and opportunity to evaluate what I want to do in the future. Our most recent discovery was that horizontally printed scaffolds were mechanically stronger and more accurate in print validity than their vertically printed counterparts. We also had two designs that consisted of a grid-like and porous-radial design. The grid design was stronger and more precise in print validity. Therefore, the design that we will carry into our torsion testing will be the horizontal grid design.

Scaffolds can be used for many medical applications, such as bone graft applications or any area that needs to recruit neighboring cells to heal the injury. Since these scaffolds are 3D printed, these medical devices can be designed according to the exact anatomy of the patient due to the accuracy and variability that additive manufacturing provides. In addition, the microCT results can provide results or insight on what the optimal material is for these medical scaffold devices. Furthermore, we still have to carry out a degradation study to evaluate how the material degrades in the body overtime. The device should be temporary (so no second surgery is required) and should degrade, but only after its purpose has been carried out. Therefore, the degrading period should be within that range.

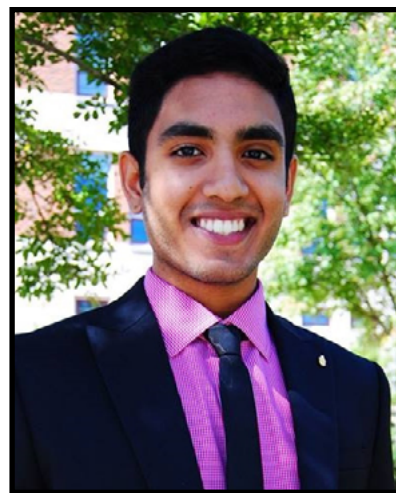
My suggestion to BIOE undergrads on getting involved with research is to email professors and faculty members if any assistance is needed in their research. Also, a student's strong interest in the research is almost always a requirement, so that the research is not only fun and exciting, but also important to the student's research goals.

Our most recent discovery was that horizontally printed scaffolds were mechanically stronger and more accurate in print validity than their vertically printed counterparts.

Tuning Immune Responses, Tuning My Scientific Passion

By Arjun Adapa, Guest Contributor

From an early age, I have always been uncomfortable with uncertainty. My desire to ask questions about my surroundings was satisfied by my love for science. During high school, I participated in a research opportunity at Johns Hopkins School of Medicine. Here, I investigated the mechanisms behind anti-tumor T cell tolerance seen in cancer. The primary objectives of the lab were to investigate the molecular mechanisms that govern the activation, differentiation, and tolerance of T cells. For my specific project, I helped elucidate the roles of two important signaling proteins, mammalian-target of rapamycin (mTOR) and TANK-binding kinase 1 (TBK1), in interferon regulatory factor (IRF) expression in mice. The over-activation of these signaling proteins can lead to the development of cancers, so they served as therapeutic targets. I gained extensive experience in Real-Time PCR, macrophage and dendritic cell culture, and western blotting. The most important thing I learned was to ask questions unceasingly and be confident in the story that my research tells. The most exciting component of my experience was working with physician-scientists and medical fellows at a world-class research hospital.



When it came time to enroll at the University of Maryland, I desired to continue similar work to combat disease. I joined Dr. Christopher Jewell's lab in the Department of Bioengineering at UMD in my first year of college. The lab's goal is to create biomaterials that can generate immune responses with specific, tunable characteristics and to further the development of biomaterial-based vaccines. The ability to engineer the immune response appeals greatly to me, as it is revolutionary and relates to my previous research.

My current research is on tuning the immune response to combat Multiple Sclerosis (MS). We recently published on the modulation of autoimmunity using nanoparticle carriers of a small molecule drug (Gammon, et al, 2015). I am extending this work by studying lipid-based carriers for the same drug. Currently, I am investigating how these liposome carriers can deliver this drug in a way that reduces T cells responsible for the autoimmune destruction of the myelin sheath surrounding axons, which manifests in neurological damage seen in MS. I have applied engineering principles and techniques, including sonication, laser diffraction for particle sizing, extrusion, spectrophotometry, and fluorescence microscopy for the creation of nanoparticle and liposomal drug vehicles. I have been able to control the signaling of Dendritic Cells (DCs), which control levels of T cells through immune signaling, in a manner that is likely to achieve reduced autoimmune responses. For example, treating DCs with our nanoparticle and liposome-drug formulations has resulted in reductions of secreted pro-inflammatory cytokines, measured by enzyme-linked immunosorbent assay (ELISA). Our current and future work focuses on delineating the interactions between DCs and T cells when they are treated with our liposome-drug formulations.

The most exciting aspect of this work has been planning experiments, developing and characterizing our biomaterial nanoparticles from scratch, because I enjoy the ability to have at least some control over the immune effects we want to see. Ultimately, that is the goal of the lab – tuning the immune response in the manner we desire!

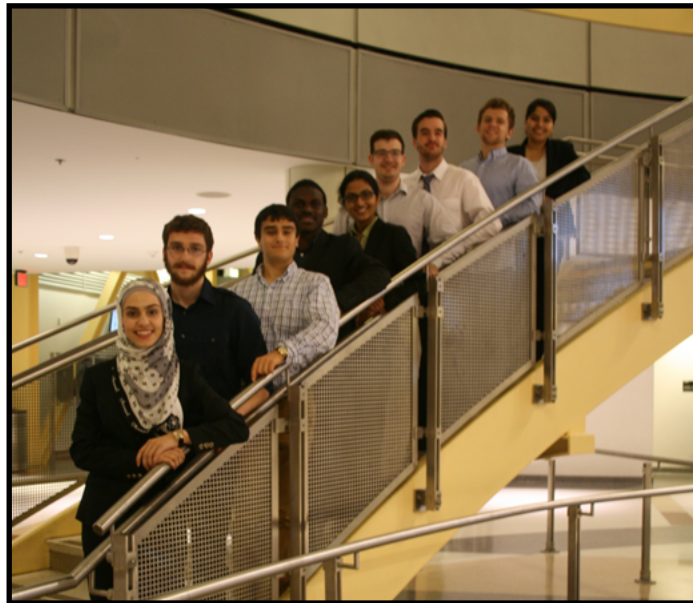
On the Cover

By Adam Berger, Editor-in-Chief and Dimitri Tito, Staff Contributor

The cover image was taken in Dr. Kofinas' functional macromolecular laboratory. The picture is a SEM image of PLGA block PEG fibers. Fibers were created and pictures taken by Dimitri Tito.

Editorial Board

The Catalyst editorial board consists of dedicated undergraduate bioengineering students ranging from sophomore to senior standing. We are dedicated to serving not only bioengineering undergraduates but also all other undergraduates in the sciences, admitted transfer students, prospective high school students, and anyone else interested in learning about undergraduate research here at Maryland!



Group photo in the Kim Engineering Building.

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Acknowledgements

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