THE CATALYST

Secrets to Success:
Grad School, Med School, Industry, Networking, and More

Entrepreneurship 101:
A Crash Course to Funding Your Future

Brilliant BIOE's:
Competitions, Research, and Capstones

University of Maryland's Undergraduate Bioengineering Research Journal

Issue No.7
Summer 2017

Want to be 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 eighth issue coming this Winter 2018! If you are an undergraduate student working on research related to biomedical engineering and biotechnology, you are qualified to submit a research blurb. Contact us via email or submit your research abstract through the link provided below. Please 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 making a contribution.

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ter.ps/catalyst4 ter.ps/catalyst5 ter.ps/catalyst6

For further questions contact us at:
thecatalystumd@gmail.com

IN THIS ISSUE

Dear Catalyst Readers,

I'm excited to introduce Issue 7 of The Catalyst: University of Maryland's Undergraduate Bioengineering and Biotechnology Research Journal. We have expanded our team, and it's larger than ever! More team members mean more content we can deliver for you. For this issue, we've continued sections from last semester, as well as added many new sections. Moreover, our design has evolved each semester, merging vibrant aesthetics with quality content to enhance reader experience. Now, as my second semester serving as Editor-in-Chief of The Catalyst, I'm proud to introduce the content for this issue that our great team has put together: a whole whopping 29 articles!

Spring semester is when excitement, anxiety, and anticipation is in the air for our graduating seniors! Not only are they completing their capstone projects, but, most importantly, they are deciding the next chapter of their journey. Before they left, we got a hold of them to see how they landed their dream jobs and how you can do it too. Senior Daniel Wang discloses his secrets for navigating career fairs, branding yourself, and ultimately landing your dream job or internship in our Networking article. The Senior Spotlight: How they did it section disseminates advice from Tomer Zohar, Catherine Panasenkov, Zachary Bolten, Janna Wisniewski, Angelina Nou, and Michael Tobin on how they got into graduate school, medical school, and found industry jobs. They talk about their most valuable experiences at UMD and what aspiring bioengineering students, who want to follow a similar path, can do. Additionally, we must not forget our annual Capstone articles! Dedicating an entire year to building and fixing their projects, two capstone teams shared their final devices. One team built an oxygen concentrator for low resource environments while another team designed a forced-air warming blanket for children to prevent perioperative hypothermia.

The Catalyst, founded in 2014, has had motivated and driven students help build the journal to what it is today. We caught up with some of our Catalyst alumni to see what awesome things they're doing now. In their interviews, Nathan Barber and Milad Emamian talk about their present work, and reflect on their time in The Catalyst and at UMD. Furthermore, I've had the pleasure of working with some amazing seniors who have contributed to the journal's success. Adam Berger, one of the founding members, former Editor-in-Chief, and someone who I could go to for advice regarding the journal, says goodbye to our fellow readers and welcomes a new chapter in his life. Ashlyn Lee, Assistant Editor-in-Chief of Design, has taken the journal to new heights with her fantastic design prowess. She discusses her future plans and says farewell. Michael Amorjay-Ogar, staff writer, joined The Catalyst his senior year but embraced the experience entirely. He talks about what The Catalyst has meant to him and how me made use of his time to create a strong network. All these new alumni impart words of wisdom in our Catalyst Graduates section.

Readers will recognize two familiar sections from last semester: our entrepreneurship section and research blurbs. Now that you have an idea and prototype, what next? The Financing Tech Venture article utilizes expert advice from experienced CEO and Venture Capitalist Michael Pratt to educate students on how to get funding to build their startup. The next piece in the section explains what student's intellectual property rights are when it comes to lab research. The last piece in the section is an article based on an interview with Dr. Benjamin Shapiro that serves to inform students on how entrepreneurial pursuits can rise from a professor's work in academia. Keeping with tradition, our research blurb section features short excerpts that describe student research on campus. This issue, we have excerpts from Monica Chu, Metecan Erdi, Zachary Goddard, and Hannah Palmer.

An important facet of this journal is to include articles that showcase student activities and encourage other students to join as well, building a stronger Bioengineering community. The SSEP (Student Spaceflight Experiments Program interview gives readers a chance to learn about how two UMD students designed a biofilm project that will be tested in space! The QUEST (Quality Enhancement Systems and Teams) article details the inter-disciplinary role engineering students have with business students when working on consulting projects through the QUEST program, some of which have been for biotechnology companies. The iGEM article gives insight into the student-led synthetic biology research group, who took home the silver medal in the international jamboree. The results and participating teams of the 5th annual BMES Mid-Atlantic Undergraduate Research Day competition is also shared. Our Alumni Cup article narrates the much-anticipated first place, and first time, win of the "BioBees" bioengineering team in the annual Alumni Cup Competition! The BMES DEBUT article talks about the efforts of a group of bioengineering students to build a portable machine that uses detection of brainwaves for early diagnosis of Alzheimer's.

There are a ton of startups and small companies around Maryland that are always hiring bioengineering students! The local startup section contains interviews from managers and a former employee at Flarebio Biotech LLC and Novavax, respectively. These interviews give readers an understanding of company culture, and what these companies look for when hiring bioengineering students. Our staff writers ask the questions that you can't, to help you with your job search. The Bioprocess Scale-Up interview brings awareness about the facility, their partnerships and contracts from companies in industry, and the great outcomes their undergraduates have had (100% job placement in biotech research)!

This spectacular publication would not come together without the hard work and dedication of our editorial board. Please flip to the back to see the members of our fantastic board. Catalyst readers, we hope you enjoy reading through our journal. Thank you editorial board! Thank you Catalyst readers!

Sincerely,

Havisha Garimella, The Catalyst Editor-in-Chief

SECRETS TO SUCCESS:

Grad School, Med School, Industry, Networking, and More

Networking:
Daniel Wang

Senior Spotlight:

- Catherine Panasenkov
- Michael Tobin
- Janna Wisniewski
- Angelina Nou
- Tomer Zohar
- Zachary Bolten

How He Landed the Dream Job and You Can Too

Interview with Daniel Wang

By: Ashlyn Lee, Staff Editor

Don't know how to stand out to recruiters, get that dream job, or even what you want to do post-graduation? Take some tips from Daniel Wang, a senior bioengineering major from Gaithersburg, Maryland. He'll be working as a technology consulting analyst for Accenture this August, and has advised students on networking and the job hunt in BIOE221.

His path to Accenture was rather circuitous. According to Daniel, "the best way for me to know if I want to do something is if I try it, not just read about it." He took a very logical approach to his career options and defined three levels that a job encompasses or impacts: a systems level, a product level, and a direct interaction level. At the bottom of the hierarchy is the direct interaction level, where nurses, physicians, and counselors are working "directly with the cause or the people that are in that cause". The product level is where the typical engineer is at, developing medical devices or car engines. Finally, at the top is the systems level, where one develops the systems that make those products that eventually help people down at the bottom level. "In my opinion, that has the greatest impact but it's the farthest removed from directly impacting who you want to affect."

Keeping this approach in mind, Daniel started in the middle, on the product level. He didn't like research as much as he thought he would, "because there's not as much immediate impact that I can see out of it. You have to be very long term goal oriented and it's a little slower." After ruling that out, he moved on to the systems level. This past summer, he interned in a supply chain role for Dupont, a large chemical company. "Now I'm dealing with approximately 400 warehouses, manufacturing plants, talking with people on a global basis, having to hop into a call with China at 10pm at night to make sure this whole supply chain works. One little thing could screw up the whole system." Being involved in this big decisions kept Daniel interested, but he still craved more direct interaction. This led him to consulting, which is on the systems level but "at the same time you're directly talking to people all the time."

Getting all of that experience and deciding what to do wasn't an easy process, so Daniel has a novel's worth of tips from his own successes and failures. In general, when looking for jobs or internships, he encourages students to "never sell yourself short". "You may think that you're not competitive against another applicant, but you can't think that just because you didn't get an internship or job, you're worse than this applicant or you're less qualified. It could just mean that you didn't prepare right or you didn't do the little things right that would have set yourself over the edge." These little things add up - they can include properly giving a handshake, properly networking at career fairs, or wearing professional attire. It gets even more detailed during the interaction with the recruiter. "Your goal should never be to just drop your resume and bounce. The whole purpose is to show face and make them remember your face, so that when they look at your application, they remember your face and have a good impression regardless of what they just read." That's not to say the resume isn't important. Daniel describes fixing it as an iterative process, not a one-time deal. Having someone that already has the position you want, or even alumni, review your resume will be much more helpful than random friends.

When torn between potential career paths, Daniel suggests first doing as much research online as possible, but also realizing that you can't do everything. When in this position, he talked to people in those career fields to get answers to burning questions - "why did you do this over this, why didn't you do this, what did you find interesting about this, do you really wake up every morning and love what you're doing?" Once you've narrowed it down, actually get your feet wet. "It's okay if you don't want to do it at the end, because sometimes knowing what you don't want is just as valuable as knowing what you do want to do."

One technique he shared with students in BIOE221 is the practice of "branding yourself". Essentially, you start with understanding what your strengths and weaknesses are, and then decide what you want to advertise about yourself to a company whenever you connect with them, whether it be online or in person. Most importantly, make sure everything correlates. Daniel gives two examples: someone out of the box and ready to go, and someone very hardworking that walks the fine line of sticking to the status quo and pushing it. If you wanted to go with the first case, he advises wearing a different color suit, making your resume look a little different, and smiling and being more peppy. In the second case, you would wear a black suit and have a typical resume, but still do something smaller to differentiate yourself. "You just have to make sure that whatever you're trying to advertise yourself as, everything else correlates with that - because if there's any disconnect, there will be a problem with that and they're gonna notice."

Perfecting this doesn't come naturally. A big challenge Daniel had initially was even accepting that he was doing something wrong, and then addressing it. He noticed he was doing what most people did when they didn't get an interview or job - blow it off. "What I started realizing is you have to treat it as you do a student when they fail a test. They look at the problems they got wrong, and if they don't know why they got it wrong, they'll go up to the teacher and ask why." In the same vein, Daniel started e-mailing recruiters back to ask how he could improve the next time he applies. Not only did he learn what he was doing wrong, but it helped show recruiters that he wouldn't stop even if he failed. "Get something out of your failure."

Now that you've branded yourself, the next step is the nerve-wracking career fair, which Daniel has down to a multi-step process. First, do your research on the company and who is going to show up at the career fair. "Know that face, know their background by whatever means necessary. Social media is everywhere - search Facebook, their company website, LinkedIn, anything." Second, prepare to wear something that will make you stand out just a little, and make sure you have a business portfolio. "Whatever company you're trying to talk to, you're not going to remember every single piece of information that you researched, so write quick reminders in your portfolio." Third, get your jitters out by talking to a warm-up company that you don't care as much about. Finally, when you get to your target company, try to steer the conversation to your research about them. It's best to get them talking about themselves rather than the company, "remembering that they're also people as well. They're not only slaves of work." At the end of the conversation, get their business card and follow-up with an e-mail, where you can even set up another conversation and keep giving a good impression.

But is this process different for graduate school, medical school, and industry? After some experimentation, Daniel is finding that it's essentially the same, but each one has different values. "Business values initiative, hard work, open-mindedness, impact. Medical school values altruism, an empathetic and serving attitude." Once you understand your audience's values, you can tailor yourself to advertise to them.

Career fairs aren't the only resource to get your foot in that internship or job. At the Engineering Co-Op and Career Services Center, Daniel has found contacts at companies he's wanted to work for, and demonstrated initiative by reaching out to them. He's also done mock interviews through them and realized that it's the company's "quiet way of starting to recruit applicants. If you do a good mock interview, they might ask you to come back for an actual interview." LinkedIn is a great resource if the company you're interested in doesn't recruit at Maryland. Daniel has gotten multiple interviews just by finding a recruiter or person with his position of interest on LinkedIn and blindly reaching out. Set up a phone call to learn about the company and that person's interests. If you've had a good conversation, let them know that you're actually applying for their position and would appreciate some tips, or ask if there's anyone else you can contact to learn more. "Most times, they will put you in contact with the recruiter, which is your end game, because they're the one reviewing your application initially." That person also becomes a resource in the company that can advocate for you to the recruiter.

After all of his ups-and-downs during a four-year journey, the one thing Daniel would have changed would be to "accept failure way earlier and not have hard feelings about it." He realizes now that engineering students often think they are the smartest and the brightest, so they will have no problems talking to a recruiter at a career fair. On the other hand, business students have networking and interviewing experiences drilled into them from day one. "The whole mindset of being able to talk like a person, and practicing that - that's not easy. There's a lot of feelings - like the nervousness, the amount of times people say um, the way you need to advertise yourself." His final advice is to continue iteratively practicing these techniques, "until that point where you're failing very minimally."

SENIOR SPOTLIGHT

What will you be doing next year and where?

Catherine- I have accepted a job offer with Terumo in Elkton, Maryland. I will be working as a sustaining engineer which means that I will be assigned projects that focus on process and product improvement. The product line that I will be working with directly is a set of tools used by clinicians in open heart surgeries.

Michael - Next year I have accepted a full-time position through the IRTA postbaccalaureate program with the National Institute of Health. Specifically, I will be working with the National Institute of Biomedical Imaging and Bioengineering (NIBIB) in the Laboratory of Cellular Imaging and Macromolecular Biophysics (LCIMB). I will conduct research on the facilities' state of the art scanning electron microscope using ultra microtome insitu-3View SBF-SEM to generate and visualize 3D structural information to reconstruct 3D cells.

Janna - Next year, I will be working as a Genomic Analyst at Personal Genome Diagnostics (PGD) in Baltimore. PGD is a small but rapidly growing biotech company that has developed technologies and procedures to better detect genetic markers in cancer cells (from clinical samples, or tests for pharma companies developing new treatments), which may point to new treatment options.

Angelina - PhD at MIT's Biological Engineering program.

Tomer - Come next year, I will commence work on a Ph.D. in biological engineering with a focus on biomedical device research at MIT. A Ph.D. will ultimately allow me to further the field of biomedical device research through a private industry career in R&D while maintaining a presence in academia.

Zachary - Next year I will be attending the University of Maryland School of Medicine in Baltimore.

What excites you most about this new step in your life?

Catherine - I am most excited to get hands-on technical experience in the manufacturing industry. I eventually would like to go into engineering project management, but I think that it's extremely important to have technical experience before starting management. I am also looking forward to relocating to a new area and meeting new people in my town and at work.

Zachary - I am excited to learn more about the human body and medicine as I begin my courses in the fall. Some of the things I am looking forward to next year are starting my anatomy class, living in Baltimore, and meeting new people in medical school.

Why did you choose industry vs. govt vs. academia vs. medical school?

Janna - I chose industry because I knew I wanted to make and save some money out of school. I do still see myself pursuing higher education in some way (possibly getting my PhD later on), but i didn't choose to do that right now because I wasn't exactly sure what area research I would want to pursue. I'm excited to see what the biotech industry is like, but am definitely open to the idea of returning to school to learn even more!

Tomer - I believe that those who wish to get a Ph.D. should love the pursuit of solving a problem as much as finding an answer. Moving forward I am excited to tackle bottlenecks involved in treating, monitoring, and diagnosing the human body through unique approaches, improving global health one device at a time.

SENIOR SPOTLIGHT

What do you think best prepared you in BioE undergraduate for the next steps?

Michael - I believe that the wide range of classes I have been exposed to as well as the resources I have developed have best prepared me for the next steps I will take. I will graduate from Maryland this Spring knowing that I received an education and experience that has prepared me for life beyond the classroom where I can truly make a difference.

Angelina - For me, I think the breadth of the major was a huge asset- even though I'm not an expert in any sub-field, I can hold my ground if I'm talking to other people about a fairly wide range of topics. Along those lines, I think knowing that I don't know anything in depth is helpful, because I think I've learned how to ask better questions and how to learn things in depth as they come up.

What specific BioE undergraduate experience(s) helped you reach those next steps?

Zachary - The research experiences I gained through the BioE department have been the most helpful in journey to medical school. Working in Dr. Adam Hsieh's lab laid the groundwork for my interest in medicine and pushed me to apply for a pre MD/PHD summer program at IU Medical School. Both solidified my decision to apply to medical school.

I began working at the BioProcess Scale-Up Facility on campus after hearing about the opening through a department announcement. Through my position there I have had the opportunity to network within the biotech industry, which reinforced my desire to enter the industry after graduation. Additionally, I have taken advantage of the annual BioE networking reception in the spring as well as the career fairs that other programs within the Clark School of Engineering offer.

What advice do you have for our BioE undergraduates who want to go to the same field?

Catherine- Reach out to students, alumni, and faculty for guidance and networking. BioE is challenging and so is determining what career you want to pursue, so remember to utilize those around you.

Michael - My advice for BIOE undergraduates looking to go into a similar field would be two-fold: starting early and not limiting yourself. First, start researching early in your undergraduate experience to get a feel for if research is something about which you are truly passionate. In addition, by starting early, you open yourself up to more possibilities than those who start later. Second, do not limit your interests too soon. Bioengineering is a large field with a plethora of research opportunities. The best way to find out your particular areas of interest is to determine and experience a variety of fields so that through elimination you can be sure of your passion for the field throughout your career.

Angelina - People in the department are surprisingly invested in just you achieving your goals, so don't be scared to just talk to people and go for things! Also, it's okay to not have a clear plan- I've changed my mind about my priorities so many times, and I think really the point of right now is to explore the field and figure things out about yourself!

Tomer - Come next year, I will commence work on a Ph.D. in biological engineering with a focus on biomedical device research at MIT. A Ph.D. will ultimately allow me to further the field of biomedical device research through a private industry career in R&D while maintaining a presence in academia.

Zachary - Be open to new experiences regardless of whether they relate to medicine or your application. You never know what you will learn from the experience or how it will shape your goals for the future.

CATALYST ALUMNI

WHERE ARE THEY NOW?

Nathan Barber

Nathan Barber graduated from the University of Maryland in Bioengineering in May 2015. During his time at Maryland, he was active in Dr. Bentley's lab and helped start the iGEM team. In addition, he was part of the founding editorial board of The Catalyst. He is now at Accenture Life Sciences in Philadelphia. If you have any questions, please feel free to reach out to him at nathan_b3@verizon.net.

Q. What do you do now?

A. "I am currently working at the interface between the business side of pharma and technical engineering side of developers. I am currently working on an application that is used in clinical trials to get FDA approval. This program helps plan the trials and can drastically reduce the time and money to push a drug through clinical trials. It takes up to 7 years and 1 billion dollars to get a drug to market, so every day less can save $3 million. Thus, our software is right at the center of biotech and bringing products to market. We want to help companies such as Merck, Pfizer, GSK, AstraZeneca, and Novartis bring drugs to market more effectively and efficiently. The cool thing is that even though we are consulting, we own the product. This is not the Accenture norm but started because of a desire for drug companies to work together and productize it. Ultimately, if we can save companies money, then they want to invest in our product."

Q. What do you enjoy about working for Accenture Life Sciences?

A. "For me, I get to be in the life sciences industry, dealing with both the engineering and business side biotech. Being at a consulting company, my job is really fast paced and changing every day. I was not hired to do stuff that is easy, but rather to do stuff that challenges us and requires ingenuity. I enjoy the hard critical thinking aspects. In my newest project, I also get to travel around the world every few months which is neat. Finally, I love the freedom that I am given to pursue my own side projects. If I have a well-thought-out idea and lots of motivation, the company is willing to give me funding to get it off the ground. I have had several ideas that I have been able to get funding for and I enjoy having willing leadership that will take chances on my ideas."

Q. Looking back, what did you enjoy about The Catalyst?

A. "Looking back, I really enjoyed the group of highly motivated students that wanted to see a change and see the change through. I think this was awesome. The student ambition to do great has really seen its fruition through The Catalyst. It is great to see the new issues and how they have really transformed and gotten even better with time."

Q. What do you think helped you get where you are?

A. "Generically, it is the idea of looking for opportunities and creating them yourself if you cannot find them that helped get me where I am. I suggest that you take risks and chase the opportunities yourself. Show your passion! If you are interested in something, talk to experts about it. Establishing relationships with really important people was also due to me just talking to them. If you see an article about the way that regenerative medicine is changing the landscape for tissue engineering, send it to Dr. Fisher and ask for his thoughts. You'll be surprised by what you'll get back. As a pioneer in some of the activities I was doing in college, I gained a lot of skills. Although I did not always take the "safe" route, taking a risk that can lead to reward is important. What is really pushing my career ahead is not just doing the routine stuff, but rather figuring out to solve the unknown. Trying to figure out a solution without much guidance teaches you ways to think critically and work around issues. Try and do this in the University and see how it can impact you."

BY: ADAM BERGER, STAFF EDITOR

Milad Emamian

Milad Emamian graduated from the University of Maryland in Bioengineering in May 2014. While at Maryland, he was a member of Dr. Bentley's lab and was a part of the Gemstone Honors Program. He was also a founding member of The Catalyst in his last year here. After graduating from the University of Maryland, he spent some time at the NIH and a DC intellectual property law firm before starting the Interfaces Program at the University of Pennsylvania in Fall 2016. If you have any questions, please feel free to reach out to him at miladsemamian@gmail.com.

Q. What do you enjoy about what you are doing now?

A. "For me, as a first-year in the Interfaces program, I am doing entirely coursework before beginning lab research this coming summer. What I like is that I am getting a really broad exposure to various areas that I would not have received an introduction to otherwise. The classes that I have been in for the last two semesters are either imaging/bioengineering courses or didactic medical school courses. In the prior, I am learning the theory and hands-on side of bioimaging research. In the latter, I study areas in biology. I am enjoying getting this comprehensive experience."

Q. Looking back, what did you enjoy about The Catalyst?

A. "I liked that even though it was a project within bioengineering, I had not done anything similar before. It allowed me to explore a new opportunity and help pioneer a new foray for the bioengineering students. For myself, being able to go to class was one way to get at the material, and joining a lab was a great way to get a perspective on other facets of bioengineering. The more ways that one has to approach the topic, especially in the real world, the more they will be able to get out of it. I found it rewarding being a part of something that could help others see the same thing. This is what being a bioengineer is about - applying what we learn."

Q. What do you think helped you get where you are now??

A. "One thing that I found to be particularly helpful was having an open mind. I did not initially apply to Penn for this specific program, but there was some information about it on the application form - reading this piqued my curiosity, so I applied for this particular program. Keeping your mind open to avenues you may not have originally set out for can be really important. Although I had experimented with different areas in bioengineering, I was a little bit undecided in what I wanted to do and that led me to try lab work, clinical medicine, etc. Trying things out helped me discover my passions. In exploring different options, you do not always need to have them build directly to something else. It can be an enriching experience whether it becomes your focus or not."

Q. If you could change one thing in your bioengineering path, what would it be and why?

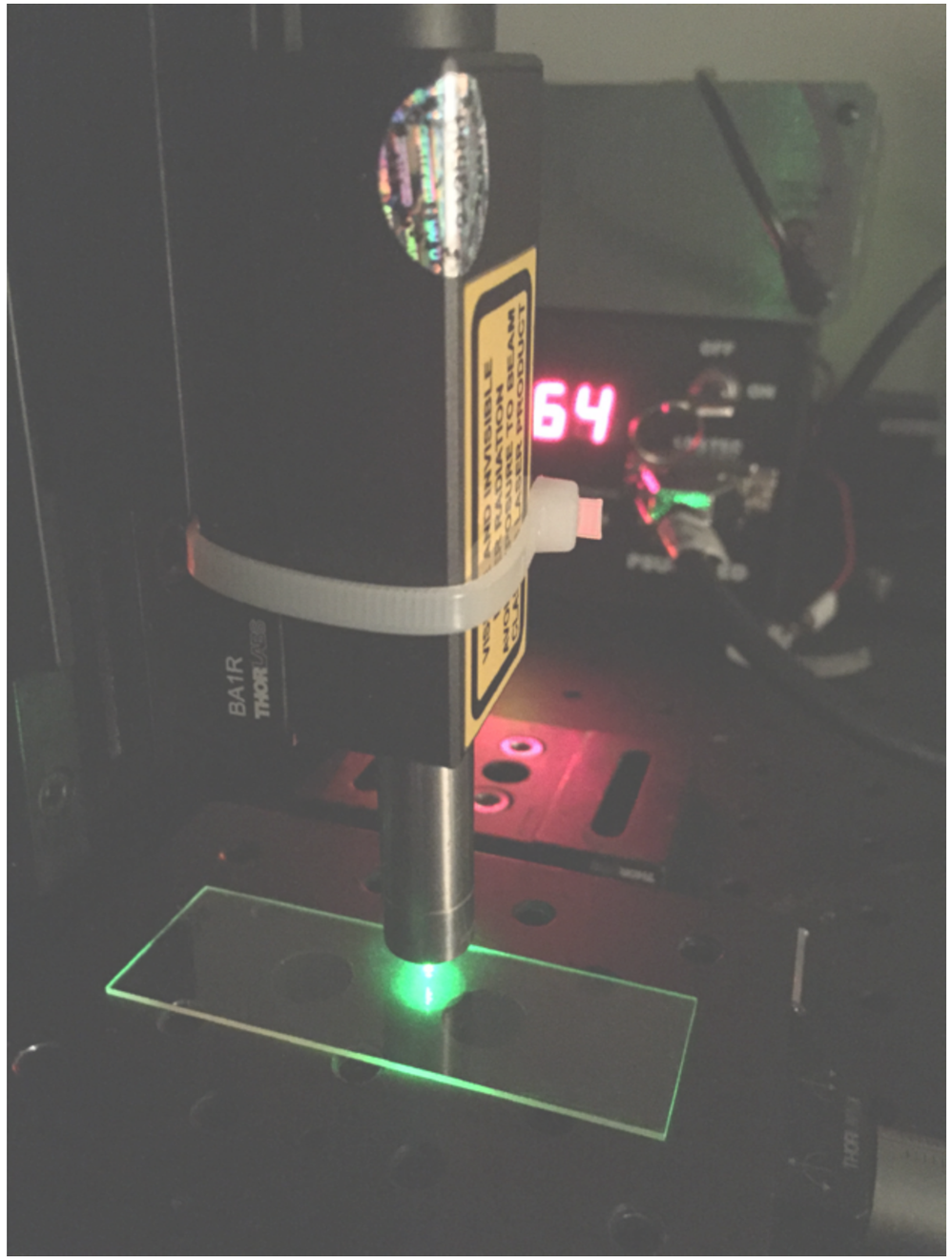
A. "Although the curriculum has changed since I graduated, I was learning MATLAB and programming in general to complete assignments, as opposed to learning through personal interest projects. I wish that I had taken greater efforts to learn interesting applications that build upon the foundations of what we learn in undergraduate, during my own free time. A greater familiarity with a diversity of bioengineering topics would have been very helpful for me as I moved on."

Q. What did you do between bioengineering undergrad and Interfaces?

A. "When I first graduated, I stayed on in the Bentley lab for about 3 months. I then went to the NIH (NHLBI) to the Epithelial Systems Biology Laboratory for one year. In the meantime, I continued volunteering. For a brief period after leaving the NIH, I spent my time on a combination of job hunting, volunteering, and preparing for the GRE. I then worked for about 8 months at SKGF, which is an IP law firm in DC, as a patent paralegal in their mechanical group. I enjoyed the experience at the law firm enough that I could see myself doing this in the future. Having a legal role in the bioengineering area is one potential path of interest for me."

ENTREPRENEURSHIP 101

How to discover, fund, and finance the future



Financing a Tech Venture

Angels? VCs? Learn about how to finance your startp today!

Intellectual Property of Undergraduates

Ever wonder how we get patents for our research? Find out here!

Faculty Entrepreneurs: Dr. Benjamin Shapiro

Professors can have startups too! Learn more about Dr. Shapiro's journey and startup.

Novavax Inc.

Find out about how students can break into the industry and learn about a prominent vaccine company in the process!

Flarebio Biotech LLC.

Learn more about how bioengineers can contribute to manufacturing and biotechnology today!

Faces of Faculty: Dr. Ben Woodard

How a facility here at UMD helped create breakthroughts in infant formula, vaccines, and more! Learn about Dr. Woodard and the Bioprocess Scale Up facility.

Financing a Tech Venture

By: Havisha Garimella, Editor-in-Chief

So you have a brilliant idea for a biotech start-up? You want to turn this idea into a reality... but how? Where's the money? Mr. Michael Pratt, a lecturer in the University of Maryland's Technology Entrepreneurship (MTech) Leading and Financin the Technology Venture course, is the perfect source to answer these questions.

His background precedes him. Prior to becoming a lecturer for MTech, Mr. Michael Pratt served as a CEO for a plethora of companies, working for almost two decades in startups. Some of these were biotech startups including; Point of Care Technologies, Adlyfe, NeoSight, Chondros, and Galt Associates. He has raised "over $70M of angel and venture financing. He has co-founded or held C-level roles at numerous early stage companies, with five exits." He holds a BS in Finance from East Carolina University, an MBA from Massey University in New Zealand, and an MS in Marketing from Johns Hopkins University. He now runs an early stage venture capital fund.

The following valuable tips were shared during an interview with Mr. Pratt:
A lot of bioengineering students go through capstone, building prototypes to solve specific issues. Assuming they want to create a start-up from this, they will need to find ways to obtain funding. Well first, if the team has a working prototype, it is easier to get funding than if they don't . Venture Capitalists don't typically invest in early stage companies, so when it comes to funding, some of your best options are seeking angel investors that have invested in biotech companies before, as well as applying for grants. It is important to research and identify which angels and VCs like to invest in biotech companies and pursue them. Early-stage startups should focus on getting angels, as angels will typically invest in early-stage startups while VCs will not.

So wait a second… What the heck is an angel? For that matter, what is a Venture Capitalist?
Angels are investors who invest in companies, usually in the early-stage, and may or may not receive equity in the company in exchange for the investment. Venture capitalists (VCs) are investors that almost always get equity in the company and, generally, invest only in the later-stages of a startup. Equity is essentially a percentage ownership in the company. So, when companies raise capital by selling stock to investors, the new stock issued for the investment translates to a certain percentage ownership of the company held by the investors.

Angels invest their own money while VCs invest funds that are funded by institutional or private limited partners. Angels often invest in convertible notes (a debt instrument that converts into equity when a "priced financing" is completed by the company), although some will invest in "seed rounds" which involves the issuance of equity to the Angel.

Michael Pratt

When selecting an angel, you want to make sure that they have a good network of other Angel investors as well as VC's. Past successes of an Angel are also important considerations.What you are looking for in an Angel investor is NOT just their investment - rather, you also want to be able to use their connections for introductions to potential strategic partners and VCs at the appropriate time in the investment life cycle. Pursuing an investment from a VC is highly competitive, so if your Angel investor has a good VC network, they can often help to secure meetings with VCs.

In the early-stage, to increase your chances of getting funding from angels (or any investor for that matter), it is critical to have a working prototype of your product or solution. After receiving angel funding, the use of the Angels' investment is often used for further developing the prototype and/or for further testing and product validation . Angels understand the uncertainty of product trials and validation. To protect your intellectual property (IP),you may want to consider filing for a patent if the product is patentable, but a patent is not always required to get funding. It is important to consider that getting FDA approval is a long road, and requires a lot of money and time, so it is highly likely you'll need a strategic partner who is interested in your product or solution, or find VCs who are willing to invest in such products.

So what do investors look for when making an investment?

- Market opportunities-Is there a market for your product? Is it large enough to be worth a risk?
- Management team – Is your the team strong? Do members have a balance of skills (i.e. marketing, sales, engi neering expertise) that will help grow the company?
- Momentum- Have you made significant progress before coming to them (i.e. prototype or company testing)?
- Money- How much money is needed by the com pany and how do you plan to spend it? How much money do they (investors) want to invest?

When talking to an investor in the early-stage of your start-up, a business plan is not necessary because too many things are still unknown. Business plans are used further along in the process. However, it is important to have a "pitch deck". In the pitch deck, you want to talk about the problem your product solves, your team, your product, and your momentum. You also want to explain what you will do with the money you get, and include some sort of financial projection. When making such projections about revenue and customers, make sure they are reasonable.Reasonable assumptions can be made by looking at the financial information of competing companies. Investors know these are assumptions, but they shouldn't be outlandish. Momentum constitutes any progress that has been made, such as a prototype or going into trials. Usually, a medical device company requires less money to fund than a pharmaceutical company. Because drug companies require a lot of money, such start-ups have a lower probability of getting funded.

Before going to investors, founders also need to consider their corporate structure. There is no simple answer detailing the best corporate structure for biomedical device companies. It is circumstantial and based upon funding requirements. A Limited Liability Company (LLC) or C-corporation can get investments from angels. VCs, on the other hand, generally only invest in business structures that are C-corporations. The benefit of an LLC is that members of an LLC are not personally liable if debts are incurred. When the LLC needs to get VCs on board (because the company needs bigger money), they can file the necessary paperwork to change their structure to C-corporation. These "conversions" will generally have tax implications involved with the change and so, you should engage the services of a good corporate attorney before doing so.

Equity splits of the founding members of an early-stage company should NOT be done too early - rather ONLY after a reasonable time period of working together where each of you can examine and evaluate the relative contributions of each member.

During financing rounds, equity given up to the investor depends more upon the investor than the founding team. "At end of the day, the investors are in the driver's seat." Investors will typically take 20-33% in early investment. Your team then has to decide if you all want to take the money or not. The"pre-money" valuation of your company (i.e., the value of your company BEFORE the investor's money goes into the bank, which is stated in a term sheet given by the investor to the company), will determine how much of your company the investor expects to own AFTER the investment (the amount of the investor's investment divided by the pre-money valuation). If you are not satisfied with their valuation, then you need to make a case as to why you are worth more, or look elsewhere. Terms sheets are negotiable, within reason.

This interview provided great information that we hope will help you as you figure out how to finance your ventures! Remember, first have a working prototype. After you have a prototype and a vision for company, recruit others that will make your founding team stronger. Then, research angel investors that have experience with your industry, and reach out to them. Prepare a pitch deck, and secure the funding. After you've used angel money, and want larger amounts of money that an angel cannot provide, network through your angel and reach out to VCs. Good luck to your future endeavours!

Intellectual Property of Research

The University of Maryland contributes heavily to the scientific community, not only through its professors and graduate students, but also through its undergraduates. Many research opportunities present themselves for undergraduates, either in a professor's lab, in a class such as Capstone, or through their own pursuits with university grants. The overarching question that plagues the minds of young researchers appears to settle around: what is mine? What as an undergraduate researcher do I own, and have the intellectual property rights to license or use as I will? Mr. Pasquale Ferrari, from the Office of Technology Commercialization, who helps handle intellectual property at the university, helped to boil this question down to one overarching question: who paid for it?

Most undergraduates that involve themselves in research, work under a professor, whether it be in the Fischell Department of Bioengineering or any other department. These young researchers, gaining experience in various fields, from nanotechnology to immunology, receive their funding for their projects from the P.I. of their lab, who in turn receives their funding from one of a few places: the university, industry, or the government. Since the University of Maryland is a public research institution and has close ties to many government agencies in the area, a large amount of funding for the university comes from government grants. Because of this, the government has rights to the intellectual property developed with its funding. Therefore, unfortunately, undergraduates who work in a university provided lab, with all the expensive and interesting equipment included, receiving a stipend from the professor or university, likely have an assignment obligation to the university for the research they conduct. However, there is hope! Mr. Ferrari, says that you can potentially gain ownership of the intellectual property in one of two ways. First, if the student was not paid by the university, sponsored by the government or industry, and received permission to use resources not customarily provided before the IP was developed, then ownership might lie with the student per certain terms in UMD's IP Policy. Second, you can petition the government for government sponsored work that the university has declined to pursue; unfortunately there is no petition process directly to the university.

The process to obtain intellectual property may appear complicated, complex, and futile, but fear not fellow bioengineers, there are a few ways in which intellectual property rights may be obtained relatively easily. Mr. Ferrari tells us that one of the most common pieces of research students have ownership over is their Capstone project. Since this project is part of a class, all students are offered the same resources, and students receive minimal funds from the university, which is not the same as a stipend or traditional funding by the university and thus students have rights to their Capstone projects, licensing and marketing them as they wish. Other university programs, such as Gemstone, also offer the same situation where the undergraduates who develop their idea using grants from the program —but who are not paid by the university nor sponsored by industry or the government— generally have the rights to the research. If,as a researcher, you want to secure the rights to your research, the Startup Shell offers many opportunities for product development that allow the entrepreneurs to still own the IP after development.

While all these rules and circumstances concerning intellectual property seem daunting and confusing, if you feel inclined to explore something you discover while working under a professor, discuss the case with OTC to determine your rights. If you want to further develop any project created through a program or in a class, explore its potential. Overall, just remember to contact the Office of Technology Commercialization for any questions concerning what rights you hold to the research you are conducting because it is better to make a phone call than to receive a lawsuit.

By: Michael Hildreth
Staff Editor

Faculty Entrepreneurs: Dr. Benjamin Shapiro

By: Loren Suite, Assistant Editor-in-Chief of design

Dr. Benjamin Shapiro is a professor in the Fischell Department of Bioengineering who has formed a spin-out a company based on his research at the University of Maryland. His involvement with magnetic drug targeting research began over a decade ago, and the specific invention that led to Otomagnetics was based on a phone call from an ENT (ear, nose, and throat) group. This group pointed out that although candidate drugs existed, there was no good way to deliver those drugs to the cochlea to treat hearing and balance conditions.

Based on his prior experience in magnetic targeting, his group invented a simple device that could magnetically inject therapy, including into the cochlea. A few years later, after results in bench-top and pre-clinical studies, Otomagneitcs was spun out from the University. Otomagnetics' technology is a "non-invasive method to effectively deliver drugs and other therapeutic payloads to inner and middle ear compartments, to the eye, and into the skin." The technology utilizes a compact magnet device to direct bio-compatible nano-particles through tissue barriers, and to the targets behind them. In preclinical studies, it has been shown to increase dose, to have a therapeutic effect (for hearing loss, tinnitus, and middle ear infections), and to be able to deliver therapy to ear, eye, and skin targets.

In terms of the difference between academia and entrepreneurship, there are a whole host of new challenges and considerations. Start-up works on a different time scale, and a bio-tech technology must be vetted through pre-clinical safety and efficacy studies, and must eventually pass regulatory (e.g. FDA) scrutiny before the technology can reach patients. Some basic skills that must be acquired for a start-up include knowledge of regulatory practices, product development, fundraising, marketing, and business skills. Otomagnetics has been fortunate in that it has been able to find experts in each of these areas, to create a well-rounded team that combines great science with regulatory, business, and clinical acumen.

Dr. Shapiro shared that every day there are challenges and difficulties that the team must solve, in order to move the company forward and have the technology reach patients. His advice for anyone considering turning their research into a start-up includes internalizing the idea that this process will take a lot of time and recognizing that it's a marathon, and not a sprint. He emphasized that, "You're committing to lots of work and lots of effort to do it." The hard work is best handled with a well-rounded team of advisors and professionals in a variety of categories. He says that one of the most common misconceptions scientists and engineers have is that the science is the hard part, and, for example, marketing and sales "is easy". Not getting expert advice on business, clinical, and regulatory issues is a good way to make unrecoverable mistakes and to sink a company quickly. Overall, he emphasized the importance of having an idea that truly makes an impact. " VC's are going to see thousands of ideas and if yours does not stand out, is not clear, or does not have a pressing need, then the idea will not be able to grow into a start-up. It must be clear that what is being developed is something that people (in our case patients) really need."

NOVAVAX, INC.

Novavax, Inc. is a clinical-stage vaccine company headquartered in Gaithersburg, Maryland with additional facilities in Rockville, Maryland and Uppsala, Sweden.

By: Ajay Kurian, Assistant Editor-in-Chief of Design

Q. Can you introduce yourself to our readers, and tell us a little bit about your background, especially as it pertains to the biotech industry?
A. My name is Saadia and I graduated from UMD's Bioengineering department in 2014. I'm currently working as a Bioprocess Specialist at Pall Corporation in Cambridge, MA. I was first exposed to the biotechnology industry when I was an undergraduate student. I took a biotech class, BIOE460, in one of the winter sessions. I believe the class was called Biotechnology and Biomanufacturing. I was not sure what I wanted to do with my career until I took this class. I had never been exposed to drug discovery and development and I found it fascinating. Afterwards, I decided to work at the professor's lab, the Bioprocess Scale-Up Facility, which helped me get my foot into the biotech industry. My first position was at a company called Novavax where I worked in Tech Transfer and Process Development.

Q. What did your position at Novavax entail?
A. I worked in two different departments during my time there. I first worked in their Tech Transfer department where I spent most of my time monitoring processes. I would present process trends to upper management on our downstream purification processes. I also participated in investigations with scientists and engineers if any of the process trends were out of specification.

After that, I moved to Downstream Scale-Up Process Development where I worked on large scale process development. I worked with a team of scientists and engineers to fine tune the downstream processes for our vaccines. This was a hands-on job and I gained most of my industry experience in this role.

Q. What are some of the areas that bioengineers could work in at an organization like Novavax?
A. It really depends on your personality and what you like to do. Process development and manufacturing are great for engineers who like to be in the lab and work hands-on.

Tech transfer and quality are great for engineers who like to sit on the sidelines and help guide the process by communication, documentation, process monitoring and investigations. These people may be in the lab or in the GMP suite from time to time but most of their work is done at their desk.

Q. What can bioengineers do to qualify themselves for positions in biotech, process development, or pharmaceuticals?
A. One of the most important things to do is get some kind of academic or industry experience while you are an undergraduate student. I took an undergraduate biotech class at UMD and ended up working at the lab for over a year. It helped me gain an understanding of how pharmaceutical drugs are produced. Some of my friends had co-ops and internships at biotech companies in the Rockville area.

If you don't get any biotech experience as an undergrad and want to pursue a career in biotech, it's not the end of the world. But it helps to have connections. ISPE (International Society of Pharmaceutical Engineers) holds networking events in the Rockville area. Biobuzz is also a nice networking tool. And use LinkedIn to see if you have any mutual connections with anyone who may be able to help you get your first job out of school.

Q. What would a typical day look like when you were working at Novavax?
A. Every day was different. When I was in tech transfer, I spent a majority of my time in meetings and putting together presentations and reports. When I was in process development, I spent most of my time in the lab working on large scale purification.

Q. What do you currently do at Pall?
A. My title is a Bioprocess Specialist. I work as a field scientist/engineer. If a customer is working on a downstream process and they are having issues with their current technologies or need assistance implementing a technology, I come in and evaluate our products.

Q. How is that position different than the one you did at Novavax?
A. I used to work as a customer that would purchase filters, chromatography columns, etc. from Pall. Now I work as the supplier, providing these items to customers.

FLAREBIO BIOTECH, LLC.

Flarebio Biotech LLC is a biotechnology manufacturing company that provides recombinant proteins and antibodies, ELISA kits, raw materials for diagnostic reagents, and food safety products to pharmaceutical companies, government regulatory testing agencies, universities, and other research institutes. It is located in College Park, MD with headquarters in China.

By: Michael Amorjay-Ogar, Staff Editor

Q. Hello, my name is Michael and I'd like to start this interview off by asking you both to introduce yourselves to our readers. Also tell us a little bit about your background, especially as it pertains to the biotech industry?
Jen: Well my name is Jen Lu and I am the Sales and Marketing assistant for Flarebio. So our company has a history of 10 years in China. Initially our main focus was on ELISA kit manufacturing, then we later started our protein and antibody product line from our parent company in China. Our company has 10 years of history overall, but our U.S. subsidiary was founded last year in February 2016. The two of us [Dennis and Jen] joined in operating our U.S. facility here. Our purpose is to focus on the sales and marketing. We have some product inventory here as well. I am the sales and marketing assistant and I am also responsible for the administration within our office. Dennis is our sales and marketing supervisor. He spends a lot of time looking for new business partners for sales.

Dennis: I am Dennis Zhang and as a Sales and Marketing supervisor, I am responsible for taking care of the customer service. Most of my time is spent collaborating with other local companies and our OEM [Original Equipment Manufacturer] distributor partners. We also attend many conferences with other universities, that are focused in life-sciences, in order to expand our commercial network.

Jen: Our potential customers are from several research labs throughout various universities.

Q. So I know you've talked about specializing in proteins and ELISA kits along with DNA. Is there anything else that your company specializes in?
Jen: So our corporation in China has different deviations in antibodies, protein, and ELISA kits. Well let me put it this way:we have different divisions and we have one division for research which only uses products including the DNA antibody protein and ELISA kits. The other divisions we have provide food safety diagnostics, diagnostic reagents, and immunotherapy. However, the bulk of our business is in China and not in other places,at least not yet.

Q. So I know you've talked about specializing in proteins and ELISA kits along with DNA. Is there anything else that your company specializes in?
Jen: So our corporation in China has different deviations in antibodies, protein, and ELISA kits. Well let me put it this way:we have different divisions and we have one division for research which only uses products including the DNA antibody protein and ELISA kits. The other divisions we have provide food safety diagnostics, diagnostic reagents, and immunotherapy. However, the bulk of our business is in China and not in other places,at least not yet.

Q. So out of what need did the company get started-what was the problem they were trying to solve and how important is your company to the field of biotechnology?
Dennis: As you know, we are a Chinese company so basically most of our employees are from China. As expected, we conduct business in a Chinese manner since we came from that particular cultural background. In order to implement our international business, we need to understand the local culture of the U.S. It's pretty different from the business scene in China. The habit of the end user is very different from that of Chinese students. Because of this, we basically started this branch in the US as a means to talk local schools, companies, and students to know what they need. This allows for the improvement of our products and services going forward.

Q. That's great! This allows for a great expansion of your business overall. If you wouldn't mind, could you both elaborate on how Flarebio is important to the field of biotechnology and beyond.
Jen: Ok so there are a lot of other biotech companies on the market that sell specialty products within the U.S. However, the advantage of our products is that we have a wide range of products within our catalog. We have approximately 9000 ELISA kits and around 40000 antibodies. Also,we have tens of thousands of proteins. The point is that there are not many companies that can produce the amount of products that we have manufactured. It is possible that two or three companies can come close to producing products at these amounts.

Dennis: OEM partnership has a lot to do with this. Original Equipment Manufacturer essentially means that in the US market,there's a lot of name brand products. We saw that and want to create our own brand as well. People need to know of our services from a brand perspective.

Q. So what would you say that the company culture is like?
Dennis: It's very young and the people we have working with us have the passion for it. We are open to all and observant of all the information that pass through this company.

Q. To wrap things up, how would you encourage Bioengineering students to consider working with Flarebio?
Jen: Well I think the main thing is for them to decide whether this is the field of biotechnology that they are passionate enough to pursue as a career. If you are an extroverted individual that enjoys communicating the new findings of our biotech industry to others, then Flarebio is definitely the place for you. Flarebio embodies the true passion behind Sales, Marketing, and Biotechnology.

FACES OF FACULTY:

Dr. Ben Woodard

By: Ajay Kurian, Assistant Editor-in-Chief of Design

So you are the director of the Biotechnology Research and Education Program. Could you elaborate on what exactly it is that you do?

The Biotech Research Program consists of two core research facilities: the Bioprocess Scale-Up Facility (BSF) which is right here at UMD and another facility at Shady Grove (The Institute for Bioscience and Biotechnology Research) which is called the Biopharmaceutical Advancement Facility. The facility right here primarily focuses on research in bacteria and yeast and the other facility focuses mainly on mammalian cell cultivation. Both of the facilities have a mission to support research within the State of Maryland and to help foster ideas and technologies that are related to the field of biopharmaceuticals. So, in general, the BSF focuses on protein expression while the other focuses on antibody production. That's a general ballpark idea of what we do but the projects deviate from time to time.

Recently, this facility on campus has done more advanced research in yeast fermentation for the brewing industry. The second major component is to foster undergraduate research and the third one is workforce development. That can range from things such as bringing in people from industry, learning new technologies, or a summer workshop for educating people who are looking to change careers or want to gain more experience working with bioreactors or purification equipment, for example.

Okay so it doesn't just extend to students it also extends to people in the industry as well. Now can you elaborate a little more about what the BSF focuses on?

It's all contract based. Companies come to us with an idea; maybe they want us to do their project in a small flask and they want to expand-hence the term scale up. The analogy I use in my class, BIOE460, is you go home tonight and you have a box of cake mix, you add eggs, oils, mix up the batter, and end up making cake for three or four people. Now how would you bake that cake for say 10 million people? So think about that from a pharmaceutical standpoint; you can produce a protein or an antibody in a small flask that may produce enough quantity to treat a few mice, but how do you produce enough quantity to cure disease in human populations of tens of millions of people?

So basically it is like taking the recipe, modifying it, and changing the size or scale of the instruments used and manufacturing it. So going back to that researcher growing protein in a 1L flask how would that translate to a 10,000L bioreactor? Basically, we help them modify that “recipe” and help produce it in a larger quantity that can be commercialized.

Going back to the contracts you mentioned what organizations or companies do you have contracts with?

We have had contracts with just about every company in the state of Maryland that focuses on biopharm or biotech. We have helped Medimmune; they have a product called synagis that treats respiratory syncytial virus, that is a virus that affects lung development in premature babies. Our facility actually helped them produce that antibody and that is one of the largest selling pharmas in the world. I believe that their last sales were about 1.1 billion dollars a year and that is a drug that was developed through a collaboration between Chem E. faculty, our lab and Medimmune.

Then there is a product called Life’s DHA, which is a fatty acid that is naturally found in breast milk. We were able to help out a company called Martek synthetically make that in an algae and now it is in every infant formula in the world. So pretty much any kid under the age of 15 or 16 has consumed that product. My daughters dairy milk she had this morning, it was one of the ingredients! It helps support brain development in newborns, infants and toddlers making it a multi-billion dollar product as well. Martek ended up selling the company for a couple billion dollars to a Dutch company, DSM.

Those are the two big ones but it can also be something as small as doing some yeast growth with Denizen’s Brewery or running a gels/westerns for research studies . It can be as small as giving a company some cells or as large as optimizing the production of a complex protein or stabilizing a genetically modified cell line. So we have been around since 1985 and we have probably done anywhere around 1100 to 1200 projects since then.
Yes I teach that as well.

Besides teaching BIOE460: Biotechnology and Bioproduction you are also involved in the entrepreneurship class, BIOE489E, as well right?

My goal in that class is to try to help students take their capstone project and create a business plan for that to see if it has some commercial potential for it. Basically, I take students through a crash course in business development, customer discovery, manufacturing costs- that kind of stuff. We actually do a venture pitch at the end of the year where we bring in a couple of VCs (venture capitalists) and the students pitch their ideas and see if it has any worth to it. Our class has produced two winners of the Engineering/Capstone business plan competition in the past two years.

I started out as an undergraduate student in the program (biotech research program). I graduated in ‘97. I came on full time after I graduated and I have been involved in some capacity with the program ever since then. It used to be just this facility here at UMD but in 2012 we introduced the facility in Rockville and in 2014 I took over the role of directing both of those facilities. I mainly handle the business development side of things as well as teaching.I leave the actual research and handling of the equipment to the two people who are actually running those facilities: Kevin Knapstein who is the lab manager at the BSF and John Kerwin directs the facility in Rockville.

That's very interesting! So I also understand you have a few undergraduates working in the facility as well?

Right now we have eight undergraduates working at the BSF in UMD and we have 4 working in the lab in Rockville. We typically hire students in their freshman or sophomore years, work with them, teach them how to use the equipment, complete and write batch records, teach them how to work with companies and then they find jobs. This program actually has a 100% job placement rate - the majority of whom go into biotechnology research and a few medical device sales or manufacturing.

I am sure there are many BIOEs who are interested in gaining real industry experience. So what would you say are some good ways for BIOEs to gain industry experience?.

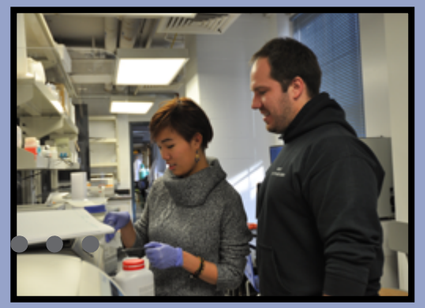
I keep telling students to go to all the networking events and career fairs in this area. There are a ton of networking events in the local DC and Baltimore areas. You really need to stand out from a stack of resumes. If you can meet someone in person ahead of time they will put your resume at the top of the pile very quickly.

I recommend an organization called BioBuzz. They do one event a month and they typically rotate between the Baltimore, Rockville, and Frederick areas. Plus there are numerous pharma societies, clubs and meet-ups in this area.

See what students do beyond the classroom!

Student Activities

Student Spaceflight Experiments Program (SSEP)



Stacey Mannuel and Colton Treadway working on their project for the SSEP competition. Exclusive interview

BMES Mid-Atlantic Research Day

UMD Biomedical Engineering Society (BMES) competed in the 5th annual BMES Mid-Atlantic Undergraduate Research Day

BMES DEBUT Competition

BIOE team members, Megha Guggari, Dhruv Patel, Christopher Look, Anoop Patel, David Boegner, Brianna Sheard, Megan Forte, participated in the DEBUT research competition.

QUEST Program

See what BIOEs are doing for their final QUEST projects!

Student research, iGEM, Capstone, and more!

BioBees Alumni Cup '17

By: Shannon Larson, Guest Contributor

The buzz is now out about bioengineering being the best major in the Clark School. The BioBees bioengineering team took first place in this year's annual Alumni Cup Competition gaining their first ever victory in the competition! One week prior to the competition, the Clark School Alumni Association had tasked all of the engineering disciplines to design and build a Rube Goldberg machine that would take a selfie. The once simple task that team members did without thought to reply to Snapchats now became the final targeted step of an elaborate 20+ step machine. With $100 given to purchase supplies, the bioengineering team set to work in a week filled with constant building. Team members were filled with passion and ideas, wanting to prove that bioengineers are the best to the rest of the engineering school. Fueled by pizza, music, and laughter over our struggles, team members put in long nights averaging over twenty hours that week for most. Using a collection of Home Depot purchases and recycled aluminum cans and other kitchen products, the machine began to come together step by step. Whenever someone suggested an idea and asked, "do you think that would work there?", the answer was always "Let's test it and see!" Everyone chipped in to pitching ideas and building in a very collaborative and open team dynamic. After many trials and scrapped ideas, the machine was finally complete and a selfie could be taken via a selfie stick rewired into a large button.

Decked out in homemade bee antennas and wearing our bright yellow BioBee shirts, the team arrived to Kim on the Friday of Engineers Week ready to represent bioengineering well. Nerves were high on competition day as we triple checked that each piece was in its right place, to ensure the machine ran properly as it had in our trials the previous night. When the hour came, we presented our BEE-utiful, yellow and black machine in the KIM rotunda to the spectators lining the staircase and two floors above. With bee puns galore, the introduction to our machine was given and then on the count of three the first step was set off. To our delight, the machine functioned exactly as expected and a selfie was taken! After two rounds of competition, our BioBees machine remained the only one to successfully accomplish all stated steps and the task without a team member having to interfere and fix something. After the judges deliberated, it was announced that the BioBees had placed first, the first bioengineering Alumni Cup victory!

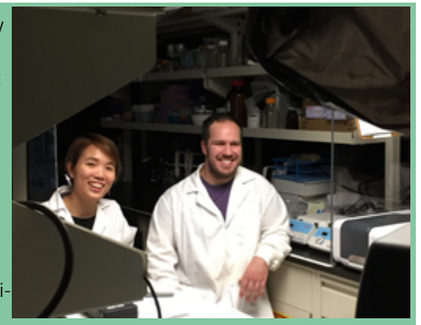
You could hear and feel the excitement not just from the BioBees team but all of the bioengineering students and faculty that were there to watch and support. This was a victory for the whole department. All of the hours of hard work and setbacks of the past week had paid off! Bioengineers are now known as a force to be reckoned with and will be on the other teams' radars as a strong competitor for next year's and future competitions. The team was very young as a whole, primarily consisting of freshmen and sophomores, so next year's team should have a lot of potential to start. If you are looking for an awesome hands-on engineering design project where you can bond with other fun bioengineers from all years, the 2018 Bioengineering team is the place to be! #BioEforTheCup

Student Spaceflight Experiments Program

By: Morgan Janes, Staff Editor

This August, UMD sophomores Stacey Mannuel and Colton Treadway will head to Cape Canaveral, Florida to watch a SpaceX Falcon 9 rocket launch to the International Space Station. However, this launch isn't like any ordinary launch – along with regular cargo, an original scientific research experiment designed by Stacey and Colton themselves will be launched into space. Once on board the space station, astronauts will carry out their experiment and send the results back to Earth for analysis by Stacey and Colton here at UMD.

This incredible once in a lifetime opportunity was made possible by the Student Spaceflight Experiments Program (SSEP), a national organization in which students ranging from elementary to college age develop proposals for scientific experiments to be carried out in space. Out of 10 proposals from the University of Maryland chapter, Stacey and Colton's proposal was selected by a committee of experts to be launched to the space station Their project, titled "Inhibition of P. Aeruginosa Biofilm Formation with Silver Impregnated Antimicrobial Silicone in Microgravity," examines biofilm growth on different surfaces in space. As they began to read through available literature, Stacey and Colton noticed that biofilms tend to grow more quickly in space than on Earth. A biofilm is a group of microorganisms that adhere to a surface and one another to create a film-like coating. Because they are responsible for more than half of all bacterial infections, biofilms that grow in space could pose serious health risks to astronauts. To address this problem, Stacey and Colton decided to examine whether or not a silver-based antimicrobial silicone surface will slow down biofilm growth in comparison to a non-modified silicone surface.



The experimental setup that Stacey and Colton will send to space is a small silicon tube containing three compartments and a maximum volume capacity of only 8.4 mL. The first compartment will contain a freeze dried P. Aeruginosa bacterial culture, the central compartment will contain two silicon surfaces and cell culture medium, and the the last compartment will contain a glutaraldehyde fixative. On the first day that the experiment is in space, an astronaut will remove the barrier between the freeze dried culture and the silicon surfaces, allowing the bacteria to circulate in the medium and adhere to the surfaces. After two days, an astronaut will then release the fixative from the last compartment to preserve the cells that have adhered to the surfaces, allowing them to be analyzed here on Earth in the future. We caught up with Stacey and Colton to ask them more about their project, plans for the future, and scientific journey to the space station. Do you have a great idea for an experiment that you'd like to send to space? University of Maryland's SSEP Chapter, which has been officially renamed Terps in Space, will hold a proposal competition again during the 2017-2018 academic year. No previous research experience is required to join! Interested students should visit the website terpsinspace.umd.edu to sign up and explore more information about the program. The director of the program, Daniel Serrano, can be reached by email at terpsinspace@gmail.com for questions.

Q: What motivated you to become involved in this project?

Stacey: I saw an email about the program and I was like, "Huh that's cool, I should find someone to do this with." I remembered that [Colton and I] did a project in physics lab together, so I figured I should ask Colton, he's a smart guy.

Colton: I thought it was a pretty good opportunity to learn proposal writing and designing your own experiment.

Stacey: We originally thought it was much more complex, but then we found out how there were so many limitations. I think that made it more interesting.

Q: Can you describe a general background of the idea behind your project and what problem you are trying to solve?

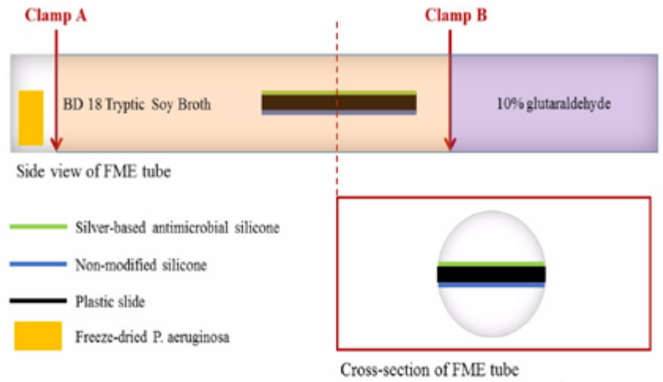
Stacey: We're trying to figure out how biofilms grow in space.

Colton: And more [specifically] how to restrict their growth in microgravity, and how well certain antimicrobials work in microgravity.

Stacey: Previously NASA did research on how biofilms grow in space and we know for sure that they grow much faster and in different shapes than they do on Earth. We want to find out why they do that and how to prevent it because biofilms are really problematic in space. For example, [they could be found] in water systems that the astronauts use, food, and [pretty much] anything else.

Q: What does the setup in the lab tube look like and what data do you expect to collect that will help you draw a conclusion?

Colton: So we're essentially going to put in two silicon surfaces, one with the antimicrobial impregnated in it - we're using silver nanoparticles - and then we're pretty much just going to let some bacteria grow in there. We're trying right now to narrow down the right time frame for [exposure to the surfaces], but I think it will be two days. Then we are going to compare the biofilm formation on both surfaces. At the same time we are going to have a control here at UMD so we can see the differences between the two surfaces in space and on Earth.



Stacey: We'll also use a fixative when the experiment gets into space two days after [the bacteria] have been exposed [to the surfaces], so we can keep the bacteria in the state they were in in space when [the experiment] comes back down.

Q: What is your hypothesis for the experiment? What do you expect to see when you receive your results?

Stacey: We're expecting that [the bacteria] are going to grow much more in space but we're expecting it won't grow on the antimicrobial surface, mostly because on Earth the antimicrobial surface has been proven to prevent around 99% of biofilm growth. That's a high percentage so we're hoping that [a biofilm] won't form in space either.

Colton: The matrix makeup of the biofilms is a little different in microgravity than it is on Earth so I guess the inhibition of [growth] might be different [than it is on Earth.]

Q: Are you actively doing any sort of preparation in the lab right now or is that going to wait until the launch?

Stacey: So far we've only been checking if the time span [for biofilm formation] is enough for two days [of exposure to the surfaces] in space and if it will be long enough to see any biofilm growth. So far it looks like the bacteria will grow properly.

Q: How did your project change from your initial ideas and brainstorming to your final proposal? Did you have to modify anything at all?

Colton: Well, from the initial brainstorming, yes, because there are a lot of restrictions on the experiment which was probably the biggest challenge. I don't know if you know about it, we have to do it all in a tiny little tube with maybe ten milliliters worth of volume.

Stacey: And there's also restrictions on what we can place [in the tube] because the astronauts can't be exposed to anything hazardous, so we were given a very limited amount of bacterial cultures we could use.

Q: What do you hope to have completed by the time of the project launch?

Colton: Well, hopefully everything (laughs). Hopefully it's ready to go up there. Right now we'd like to optimize the exact volume [of the bacterial medium]. We can't really change any of the things we're sending [to space] but we can reduce or change ratios and hopefully optimize it for the best growth.

Stacey: We also need to make sure that we get all the materials before the launch and see if [the bacteria] will grow in the same conditions on Earth before [the experiment] goes to space.

Q: Have you encountered any challenges in the lab so far? Has anything not worked the way you expected it to?

Stacey: I think the silicone.

Colton: Not so far. The hardest thing has been ordering materials - we go through the whole hassle of setting up an account here and then doing the Launch UMD campaign.

Stacey: Because we're not associated with the lab [that we work in], it is difficult to obtain some materials. Companies only provide antimicrobial silicon to big manufacturers or labs so they can't just randomly give some samples to us, so that's been the hardest part. We still haven't figured that out actually.

Q: Are you working in a professor's lab here?

Stacey: Yeah, Dr. Kjellerup. We're working in the Biofilms Lab, but she's actually in the civil engineering department. She does a lot of work with biofilms so [our project] matches up with her research.

Colton: We also got some help from her when writing the proposal. She gave us some really good ideas.

Q: What is one new thing that you learned about research from participating in the program?

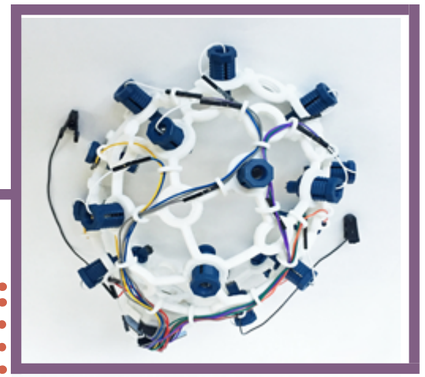
Stacey: Proposal writing.

Colton: [This type of work] is not something I would normally see in the lab - [usually] it would just be going in and doing things like cell culture and microscopy but never learning things like how to purchase materials, which is a good skill to have.

Stacey: There is a lot of administrative work that goes into the research that you don't really think about. This is especially true when you work in a lab, because often your professor just gives you something to do. If you're designing the whole thing from scratch you have to think about how to design a project, order materials, and get help. It's a lot of work.

DEBUT Challenge

By: Subhashini Arumugam
Staff Editor



The Design by Biomedical Undergraduate Teams Challenge, or DEBUT Challenge as it more commonly known, is a research competition sponsored by the NIH that challenges undergraduate students to conduct groundbreaking biomedical research with the goal of improving healthcare practices. In addition, successful teams have the potential to receive sponsorship from various companies to advance their research. The University of Maryland has several teams comprised of members of the Biomedical Engineering Society, or BMES. One of these teams is working to develop a portable machine that can detect aberrant brainwaves for the rapid and early diagnosis of Alzheimer's. Current methods of diagnosis are time consuming, unreliable, and inconvenient for those with limited access to medical infrastructure as is the case in many developing nations. To address this problem, the team prototyped a wearable device that can immediately determine any abnormalities in brain waves that may be linked to Alzheimer's disease.

The team developed this project after learning about the ineffectiveness of current diagnosis methods and the importance of early diagnosis in achievement of effective treatment. Their biggest struggle in the initial stages was combing through the preexisting literature on the subject to find ideas that were novel but also doable. Once the literature searches were over, the team needed to employ electrical engineering skills to assemble the device. Currently the team has a wearable headset prototype, and they are working on programming the instrument. To program the headset, they are collaborating with a lab in Greece who provides them with data o on human subjects since the team is unable to do so themselves.

The team was formed last semester and they have been working on their project since. They are advised by Dr. Steven Jay from the BIOE department, and have reached out to many additional faculty members for help throughout the course of their research. They are especially grateful to Dr. Idsardi for providing them with the initial headset that they have since built upon and improved.

As an undergraduate research group, they often had to subvert preconceived notions about the abilities of undergraduates. As freshman member Dhruv Patel explained, researching as "an undergrad doesn't mean you can't change lives and do something that actually matters."The group has also faced limitations in their education/background, as they often find themselves lacking the skills they need to approach an issue. For example, many members wished they had taken BIOE241 – Biocomputational Methods, to have a better understanding of programming skills. Luckily their diverse team of bioengineers, and chemical engineers has been able to acquire the required skills, and teach them to the other members. In fact, as opposed to having subteams that work on specific tasks, the team has opted to include all members in all aspects of the project, allowing every member to gain as much experience as possible.

For the next several months the team hopes to finish programming the prototype and receive approval to test their device on human subjects, an integral step in the development of their device. Beyond their undergraduate education, the team has diverse academic goals, ranging from Ph.Ds to M.Ds, and they are confident that the skills and experiences they have gained in the DEBUT teams will help them later in their academic and professional careers. All members agree that teamwork, which is the biggest component of this design project, will be particularly beneficial as they pursue their future careers. In addition, the experience has changed their perspectives on their career paths, as many members admitted their research allowed them to consider different majors and career paths. The team encourages undergraduates to get involved with research on campus, especially with projects that students can design and execute, as they learned from and greatly appreciated their experiences. If you are interested in learning more about the team, you can visit their LaunchUMD page.

BMES Mid-Atlantic Undergraduate Research Day

By: Morgan Janes, Staff Editor

This semester, the University of Maryland Biomedical Engineering Society (BMES) teamed up with Johns Hopkins University, the University of Delaware, and Widener University for the 5th annual BMES Mid-Atlantic Undergraduate Research Day. The competition this year took place at the Johns Hopkins University Homewood Campus and featured the largest turnout of undergraduates to date. Undergraduate students working on a wide variety of bioengineering projects, from microfluidics to 3D print ing and everything in between, presented their research through an oral presentation or in a poster format to faculty members, judges, and their fellow undergraduate students. In the morning session, students presented their research posters and fielded questions from attendees. This first session provided a great opportunity for participants to meet new students and learn about the exciting research their fellow peers are conducting. After a lunch break, students moved into the conference room where eight students, two from each university, delivered an oral presentation in front of all the competition attendees.

1st Place: Jordan Ewoldt (Johns Hopkins)
Project: Quantification of Myocardial Extracellular Matrix Fiber Structure

2nd Place: Margaret Billingsley (Delaware)
Project: EGFR-Targeted Nanoshells to Improve the Sensitivity of ELISA-Based Detection Methods

3rd Place: Casey Lim (Maryland)
Project: 3D Printed Bioactive Cartilaginous Scaffolds Using DMSO as a Solvent

Crowd Favorite Poster: Joanne Chan, Kimberly Lo, Veda Ravishankar, and Yasasvhinie Santharam (Maryland) Project: Integration of 3D Printed Microvilli and Sensors into a Microfluidic Gut-on-a-Chip Model - Gemstone Team BIOCHIPS

Overall School Winner: Johns Hopkins University

Yasasvhinie Santharam, a UMD junior bioengineering major and winner of the Crowd Favorite Poster award, described her experience at the conference as rewarding and unique compared to other professional conferences.

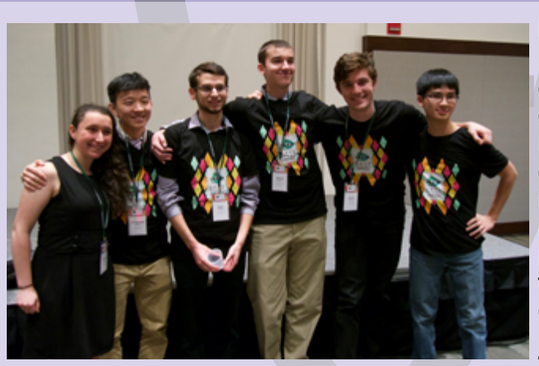
"It was nice that everyone was under the category of bioengineering but had such a wide variety of research. Some, such as ours, were focused on building devices, while others did more drug delivery oriented research, and still others had projects that incorporated a lot of kinesiology. I think because of this, the overall environment of the competition was strongly centered on curiosity, with everyone wanting to learn more about each other's projects since they each focused on such different disciplines. It was also a very supportive environment that fostered growth, with everyone asking very thoughtful questions and encouraging one another to think from multiple perspectives about their research."

Participants in the competition from UMD included Casey Lim, Melanie Zheng, Haris Dar, Natalie Livingston, Tim Holzberg, Jessica Yau, Devi Srinivasan, Joseph Dawson, Boyan Xia, Joanne Chan, Kimberly Lo, Veda Ravishankar, and Yasasvhinie Santharam. The competition also highlighted research projects conducted through the Gemstone Honors Program, a four-year multidisciplinary research experience for undergraduates at the University of Maryland. Three Gemstone teams were represented including Team INJECT, Team VESSEL, and Team BIOCHIPS. Team INJECT aims to develop a drug delivery method to treat age-related macular degeneration, Team VESSEL presented a novel method of electrospinning silk fibroin into scaffolds for tissue regeneration, and Team BIOCHIPS presented their award-winning work on the development of an organ-on-a-chip platform for the gastrointestinal tract.

Congratulations to all participants, and best of luck in next year's competition here at the University of Maryland!

iGEM iGEM iGEM iGEM

The UMaryland iGEM team is a student-led synthetic biology research group that competes annually in the international jamboree held in Boston. The team received a silver medal for their work on engineering methanotrophic bacteria to address the rising issue of methane emissions at the 2016 Jamboree.



Project Design and Goals

For the 2016 competition, the UMaryland iGEM team decided to address the issue of methane emissions and their contribution to global warming. Second to carbon dioxide, methane is the greenhouse gas that contributes the most to global warming. Human activity has largely been responsible for increases in methane emissions in recent years. Specifically, the rearing of livestock as well as the anaerobic digestion that takes place in landfills greatly contribute to these rising levels. Our team focused on how synthetic biology and genetic engineering could be used to mitigate methane emissions in general.

To come up with a solution to the problem, we looked to the natural world. We found a subtype of bacteria known as methanotrophs that are capable of sequentially oxidizing methane, thereby removing it from the environment. The abilities of methanotrophs made them an attractive subject for our project; however, these bacteria are notably difficult to work with. They have long generation times, typically around 9 hours, and require very specific growth conditions. As such, we decided to try and incorporate the genes necessary for the metabolization of methane into a more manageable bacteria, E. coli. In order to increase our chances of success we designed two possible pathways to accomplish this goal. The first pathway we termed the fructose pathway, where the ingested methane would be oxidized to form formaldehyde, which would then be added to an intermediate molecule of the pentose phosphate pathway in order to form fructose as the final product. The other pathway was designated as the formate pathway in which, after oxidizing methane to formaldehyde, formaldehyde would be further oxidized all the way to carbon dioxide. While carbon dioxide is still a greenhouse gas, its ability to trap heat in the atmosphere is about 23 times less of that of methane. To actually create our methanotrophic E. coli, the metabolic genes we had identified needed to be incorporated into a plasmid backbone. To increase project flexibility, we split our system into three different plasmids. The first contained only soluble methane monooxygenase (sMMO), the enzyme responsible for the initial oxidation of methane. The other plasmids contained the remaining genes in the fructose and formate pathways. The sMMO gene was given a plasmid of its own as it is a six subunit enzyme consisting of over 5,000 base pairs of DNA. This turned out to be a fairly important design decision as we were never able to successfully clone and express this enzyme. This at least allowed for the successful construction as well as some preliminary testing of our other two plasmids.

Modeling

Literature reviews uncovered the kinetics of the enzymes we intended to use in our artificial methanotrophs, allowing us to calculate the potential efficiency for our methane degradation pathways. Using the Matlab applet, Simbiology, a differential equation solver designed for applications in biological research, we were able to calculate the efficiency of our pathway if each enzyme was expressed at the same concentration. Our mathematical modeling recommended that we precisely tune enzyme ratios in order to improve the health and efficiency of our biological machines.

Freezer

iGEM is an expensive endeavour. Each team requires a lab outfitted with specific pieces of equipment including a -80 C freezer to keep competent cells ready for transformation. However, even the most affordable models are around $5000 USD and must be maintained by professionals. Many iGEM teams, especially high school teams and community labs, cannot afford to purchase or maintain these freezers and, as a result, fail to complete their projects.

As part of our mission to increase accessibility to synthetic biology, we developed a solution to this glaring problem: The DIY ultra-low freezer. This device is compact and modular, and with a total cost of about $300 USD, any team can afford it.The freezer is composed of solid parts held together with thermal grease and rubber bands, so it can be disassembled and repaired effortlessly. It can hold five PCR tubes or one 1.5 mL tube of competent cells, a capacity suitable for a single iGEM team. The freezer uses a custom setup of thermoelectric plates, which use an electrical current to "pump" heat in one direction from a hot side to a cold side. These plates can be stacked to reach extreme temperatures, but they pump out roughly ten times as much heat as they draw in, so when stacking plates, it is necessary to have the smallest plate on the coldest side, with that plate's hot side in contact with another plate that is ten times as large. Eventually the stack must contact a heat sink to dump all of the heat. All parts were purchased from the Maryland company Custom Thermoelectric, and a scaffold was 3D printed to hold them in place. Our final assembly successfully achieved the ultra-low temperature of -80 C, but it could only hold a limited volume and had little insulation to keep the heat in.

Outreach, Collaboration, and Education

In order to learn more about how our project could be applied, and the extent of current infrastructure that handles methane emissions, we reached out to Mr. Peter Karasik, a director at the Montgomery County Department of Environmental Protection. He arranged for us to tour the Gude Landfill in Montgomery County where we able to observe how methane is collected from the landfill and flared to prevent it from entering the atmosphere.

In the spirit of iGEM collaboration, we hosted UMaryland's 2nd annual Mid-Atlantic Jamboree, where iGEM Teams from many neighboring states came to present their projects in progress. We invited several distinguished speakers both within the University and from iGEM headquarters. Both parties were very enthusiastic about being given the opportunity to speak to motivated iGEM students.

Another part of our outreach was to reach out to the younger generation of scientists in an effort to inspire passion and excitement toward the sciences. We did this by organizing activities at the Maryland Science Center's Building with Biology event. Some of our activities included a food coloring pipetting station, where we taught kids how to use a pipette and a game of giant lego blocks, in which we explained to the kids what genes were and how they could be engineered.

Results and Competition

In summary, we succeeded in cloning the fructose and formate constructs as described above. The formate plasmid gave us difficulties, as the registry parts ordered came without stop codons. We corrected the part using site directed mutagenesis, but did not have time left to test its functionality. We also had difficulties cloning the sMMO enzyme, which had 6 enzyme subunits along with other regulatory parts we planned to implement. Our efforts on testing were directed to the fructose plasmid, since it was the first to be completed. In the final week of October, six members of the team attended the 2016 iGEM Giant Jamboree in Boston, MA. Over 200 teams from around the world were present, and we enjoyed the opportunity to get to meet them and see their accomplishments. Our team gave a 20 minute presentation and presented at several poster sessions, summarizing our results to judges and other iGEM members. We were awarded with a silver medal, and we were also nominated for one of the "Best Hardware" projects for developing the affordable -80 C freezer. All members who attended the jamboree found it to be an excellent learning experience and a lot of fun. We are proud of our accomplishments this year, and are excited to get to work on the 2017 project, where we hope to take the UMaryland iGEM team to greater heights.

Contact and Info
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QUEST

By: Aviva Borison, Staff Editor

Sandra Soltz is a senior Computer Engineering major and a member cohort 24 in the QUEST Program at the University of Maryland. When asked why she decided to join Quest in addition to an already rigorous engineering curriculum, Sandra explained that Quest is an incredible opportunity to meet other students and form a community within UMD. Additionally, the courses allow students to learn about consulting while forming deep friendships and bonding with their cohort, or incoming Quest group. From an academic standpoint, she stated:

"I learned so much about consulting, especially through the last course you take with QUEST called 490. In 490 you're given an actual client and my client was the bioengineering company BD, Becton Dickinson. Your goal in the class is to solve a problem for them, and they actually trust you like they trust a real consulting firm, which is an unbelievable opportunity...a great way to understand what it actually means to be a consultant. Through this project you get to learn about how your company operates and what they do. Oftentimes it's a great way to make professional connections for full time jobs after college as well."

In discussing her personal 490 QUEST project, Sandra explained:

"BD's primary focus is to create biotech, for instance the different materials you have in your lab like biosafety cabinets, and more complex and innovate lab technologies such as diabetes syringes. Many hospitals buy materials from BD. BD also purchases smaller companies on the side and one they bought in the 1950s was this company called Lactinex which makes probiotics. BD did very little to market the Lactinex product, and it generated revenue as a result of a fairly steady following of consumers. However, in the past 10 or so years they saw a steady decline in sales...they wanted us to come in and provide them with a market strategy to boost sales and drive Lactinex to the future."

This specific project was marketing heavy, but this isn't the case for every Quest project. Sandra happened to be given a project relatively unrelated to her major; however, many others are more technical and technology based. Most of the projects consist of interdisciplinary work and require an array of skills.

"We had a bioengineering team member who was taking these courses on transport methods and ways that medications can enter the body, and because of her background in bioengineering she knew a lot about techniques that could be implemented by Lactinex. She was able to recommend ways to improve the effectiveness of the probiotic in reaching the intestines, rather than getting stopped in the stomach. She recommended they consider reformulation and encapsulation, meaning to reformulate the pill to include more bacteria, less sugar, and less milk. So because we had her background and a business background with three finance members on the team we were well equipped to approach their problem."

Luckily they did not have to go through the entire process alone. BD stayed involved with their work through a representative who offered consistent support and information.

"We met with him once a week, sometimes twice a week to give him updates on what we had been working on, and to get feedback from him. We developed recommendations for BD and he would be the one putting those recommendations into play. "

Each Quest team is required to provide several deliverables throughout the semester. Where most teams create three deliverables on average, Sandra's group produced eleven.

"I'll give you an example of a deliverable: we had to do this thing called the map of the customer experience. We wanted to know how a customer would experience the 'journey' of purchasing Lactinex, which is currently sold behind the counter because it needs to be refrigerated. What we learned is that [Lactinex] is somewhat inaccessible because it was stored behind the counter and while many companies advertise at the pharmacy counter or in the probiotics aisle. How could we address that? We had a couple different ideas, and that would be one example of a deliverable."

"Because bioengineering is so broad, there are so many different directions you can take. You can go into consulting, medicine, biotech–there are so many options–and QUEST does have relationships with biotech companies. In addition, any engineering job you have is going to require you to present and communicate your ideas to important people and prove to them that they should trust you to bring those ideas to life. It doesn't matter what industry you're in, [communicating] is going to be very important and Quest will give you the best experience in doing that when you're presenting your recommendations to your client. Being able to communicate your ideas in an effective way is essential for any career path."

Projects

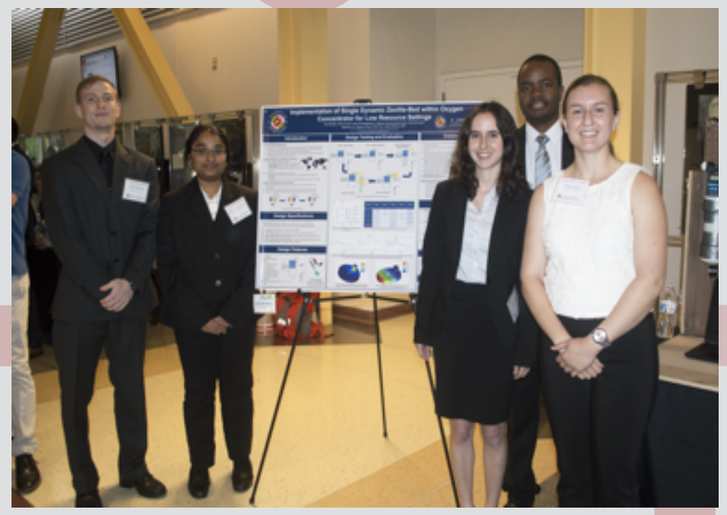
CAPSTONE

Improving the Cost and Efficiency of Oxygen Concentrators for Low Resource Settings

Julie Boylan, Diana Curtis, Pierrot Nsengimana, Lalithasri Ramasubramanian, Paul Wampler
Advisors: Dr. Gregory Payne (Professor, BIOE), Dr. Adnan Bhutta (University of Maryland Medical Center)

Oxygen therapy is an essential treatment for hypoxemiaa condition resulting in an abnormally low concentration of oxygen in the blood and symptoms of several pulmonary and circulatory diseases, such as pneumonia. Despite its importance in treating hypoxemia, oxygen is in low supply in many low resource areas of the world, which is one reason why pneumonia is still the second most prevalent cause of death in children under five.

Oxygen concentrators have been proposed as a solution to this problem, as they produce medical grade O2 from the atmosphere; however, current oxygen concentrators on the market are too expensive, require too much power, and are too complex for most low resource settings. To address these limitations, we have developed a preliminary prototype for a simplified, cost-effective oxygen concentrator that operates at a power of about 205.4 W and costs $460 to build. The device relies on the use of two cycles of compressed air through a single molecular sieve (zeolite) bed. The cycles are controlled via Arduino powered solenoid valves.



This allows for oxygen purity to rise in the system during the cycles (valves opened) and maintain the oxygen at a high purity in a surge tank while the zeolites are being exposed to air, to depressurize and regenerate (valves closed). Furthermore, the device is mechanically and electronically simplistic enough that it would not require a trained medical technician to perform any repair work. The system is most suited for deployment in a clinical setting as a stationary oxygen concentrator.

Capstone Projects

Forced-Air Warming Blanket to Combat Perioperative Hypothermia in Infants and Children

Group 4: Michael Burgan, Megan Dang, Oluwatobi Fagbohun, Angelina Nou, Devayani Srinivasan
Advisors: Dr. Angela Jones, Department of Bioengineering, University of Maryland
Dr. Adnan Bhutta, University of Maryland School of Medicine

Perioperative hypothermia occurs when a patient's core temperature drops below 36°C due to anesthesia-induced loss of thermoregulatory function. It can result in problems such as acidosis, coagulopathy , increased susceptibility to infection, and myocardial complications. 50-90% of patients given anesthesia will experience this condition. Infants and neonates are more likely to experience perioperative hypothermia because they have a smaller weight to surface area ratio. Currently, the gold standard of clinical practice to treat this problem is the Bair Hugger, a forced air warming blanket. This system involves pumping heated air into a one-use blanket that surrounds the patient in order to increase the patient's body temperature.

While this method of treatment has been successful, the design of the blanket and the method of monitoring and regulating the patient's temperature make the device less energy efficient and effective than it could be. We aim to make an innovative underbody warming blanket that is reusable and more effective and energy efficient than the Bair Hugger.

We identified two primary areas of focus to meet this objective. The first was to insulate sides of the blanket that are not in contact with the patient in order to limit heat loss to the surrounding environment and make the warming more effective. To work on this component, we generated models in COMSOL to study how the heat distribution differs for a blanket with no insulation and a blanket insulated with two different materials. The second component was to design an automated system that receives temperature input from the patient to automatically adjust the temperature of warmed air being pumped to the blanket.

To achieve this goal, we built a prototype system and collected data for specific conditions. Future work will be implemented in order to model how certain insulation designs will affect the heat dissipation of the blanket. Additionally, different types of pumps and heat sources will be considered in order to modulate for either high air force or low heat output.

Molecular Dynamics: Modeling Drug Interactions with Bacterial Membranes

By: Monica Chu, Guest Contributor

I'm currently a junior bioengineering student on the Biomechanics and Biomaterials track. I've worked with Dr. Klauda's Molecular Dynamics Lab in the Chemical Engineering department since the spring of my freshman year, 2015.

A major part of what we do is take computational models of lipid membranes generated from a set of force parameters (accounting for interactions on the atomic level), then conduct simulations on these membranes with various drugs. The goal of this research is to examine characteristic changes in the organization of lipids in the membrane and drug penetration into the bilayer.

Often the anomalies or phenomena that we discover in the wet lab cannot be easily explained. As a result, the underlying mechanisms behind experimental results end up obscured in a 'black box' in which no one really knows why something works well,just that itt does. The advantage of using computational modeling to explain experimental results is that we break the science down to an atomic level, looking at the free energies, electron densities, and forces associated with the components of the system we set up. Granted, it's not a fool-proof method of predicting membrane behavior, but at the very least it gives us an idea of what to expect when we conduct the experiment in the lab with real organisms.

The project that I have been working on in the Klauda Lab looks specifically at E. coli membranes and their responses to various drug molecules. The study will later extend into modeling drug resistance in bacterial membranes by incorporating multidrug resistance transporters into the membrane. These transporters are prevalent in bacterial membranes and are part of a mechanism that identifies drugs (eg. methicillin, penicillin, anticancer drugs) attempting to make their way into the cell, then exports those drugs back into the extracellular environment.

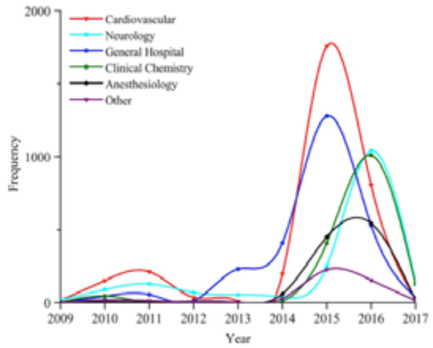
Right now, we are starting with a simple model of an E. coli membrane and inputting different drugs into the system to see how the membrane behaves with different amounts of drug molecules in the system. I've done simulations with two drugs: ethidium and tetraphenylphosphonium (TPP). These are molecules that have been studied previously and have been targeted because of their good affinity for the membrane surface and their ability to permeate the membrane. With our simulation data, we analyze electron density profiles, changes in bilayer thickness, and chain order parameters. This information can tell us how the membrane is behaving in response to the drug molecules. So far, the results from a 200 ns simulation demonstrated that TPP could penetrate into the hydrophobic core of the bilayer. This is interesting because a lot of drug molecules have a difficult time getting through that portion of the bilayer, which often presents challenges for drug delivery mechanisms. Overall, I'm hoping that this study has implications for future therapeutics that take advantage of molecules like these as a delivery medium to fight bacterial infection.

In retrospect, it's been great working with computers and learning some code along the way. It truly makes me appreciate MATLAB in the long run, even though sometimes I feel like I have a love-hate relationship with it. To the students who feel like they are struggling with the computational side of bioengineering, I encourage you to push through it! It's so worth it! Really take the time to sit down and decipher code line by line if you have to. At the end of the day, you'll come out having taught yourself something new and be equipped with a new set of skills in coding.

Solid Polymer Electrolytes for a Safer Pacemaker

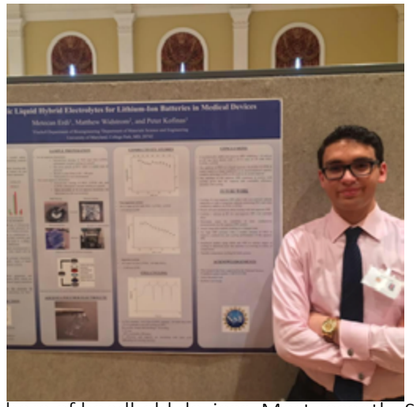
By: Metecan Erdi, Guest Contributor

Since the spring semester of my freshman year, I have worked in the Functional Macromolecular Laboratory here at UMD with Dr. Kofinas to help construct a safer battery for medical devices. Batteries play a significant role in the overall safety, performance, and reliability of many lifesaving and life-sustaining medical devices. Since 2007, there have been over 11,000 incidents of "battery issues" in medical devices per a self-reported FDA database. Pacemakers, implantable cardioverter defibrillators, hearing aids,



surgical equipment, diagnostic tools, glucose meters, wheelchairs, defibrillators are just some examples where batteries are critical for operation. My long-term goal as a researcher is to improve upon the safety of battery systems for all medical devices, while my short term goal hones in on pacemakers.

Currently, organic liquid electrolytes are a mainstay in commercial Li+ battery systems for medical devices. Due to their volatility, these carbonate-based electrolytes tend to overheat, and thereby ignite the electrolyte. To combat such safety hazards, my research in the laboratory focuses on a solid polymer electrolyte (SPE) system. The aim of my research is to better understand the electrochemical properties and microstructure of novel thin film non-flammable SPEs which are fabricated by blending a liquid electrolyte with a polymer superstructure. The resulting solid electrolyte is expected to possess both the performance capabilities of a conventional liquid electrolyte, and the low volatility of a solid. The problem of explosions in lithium-ion batteries extends beyond the scope of medical devices and into



the sphere of handheld devices. Most recently, Samsung has discontinued its flagship phone model (Galaxy Note 7) due to high profile failures of the lithium-ion battery inside the phone. In a particular case, a Note 7 erupted in someone's pocket and burned their skin (even though the phone was on standby). Similarly, battery failure in an implantable medical device could yield numerous burns under and on the skin, something that no patient wants.

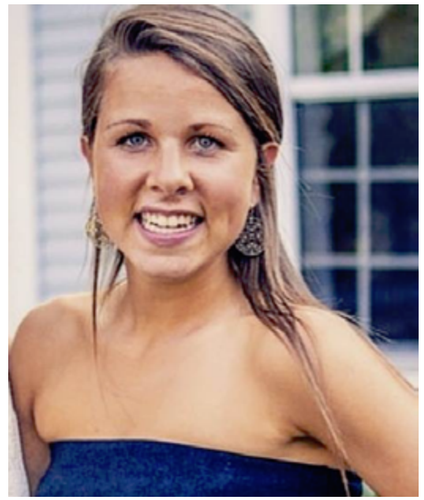
Previously, research groups have demonstrated the ability of polymer electrolytes to compete with conventional liquid electrolytes. But, what no group has done before is construct such a system with a direct application towards commonly used medical devices. Since 2007, there have been over 4000 self-re-

ported cases of "battery issues" occurring in high risk medical devices, such as implantable pacemakers. To demonstrate the improved safety features that come with a polymer electrolyte, I am developing a prototype that uses an SPE battery system to power a circuit which closely resembles one of a conventional pacemaker.

Cell Migration in the Presence of Stiffness and Curvature

By: Hannah Palmer, Guest Contributor

I am currently a bioengineering student at the University of Maryland working with six other undergraduate students in the Bioinspired Research Laboratory under Dr. Ryan Sochol.



Entering college, I pursued mechanical engineering during my freshman and sophomore year, however this past year I switched my major to bioengineering. Naturally, I am interested in the life sciences, but I also enjoy problem solving and the design aspect of engineering. I believe that studying these fields in tandem it unlocks a lot of potential application in the medical field and healthcare sector

At the Bioinspired Research Laboratory, my team has been exploring cell migration in the presence of certain biophysical stimuli, specifically stiffness and curvature. By using a three-dimensional curved substrate we are able to study cells in environment that mimic the human body. By furthering the research by Dr. Sochol with Microsprings, we use a MicroCube design to observe the cellular forces in three-dimensions. His concept used a cylindrical spring post, while we have modified the design with a square shape cube post.

To fabricate our design concept, we utilize the Nanoscribe lithography 3D printer that has the capability to 3D print models on the nano-level scare. This aspect of our research is a pioneering experience as the Nanoscribe is relatively new technology with parameters still being characterized. It is amazing to see the results of our theoretical models on constructed Solidworks CAD software become tangible prints a nano-level scale. With these nano-scaled 3D model cell substrates we are able to test the structures with cells to observe how the cells migrate across the substrate model. Being able to manipulate the cell's substrate stiffness allows for studies of cellular function and applications such as tissue engineering and biomaterials.

This experience has given me the opportunity to refine my computer aided design skills by working with Solidworks, and has allowed me to learn more about the 3D printing process in general. Furthermore, the lab dynamic of working under a professor with other students has taught me how to be a better a team member. As a student I've enjoyed the research process because unlike exams with a correct answer, research has taught me that there is no single solution to a problem. Overall, I've learned how to ask better questions by becoming a more curious person which I hope to apply in my future career within the healthcare industry.

The Catalyst Graduates '17

Ashlyn Lee

Even though I only joined The Catalyst in my junior year, I am proud of the progress we've made in revamping the journal. While I am sad to be leaving UMD and The Catalyst, I am also excited to be relocating to Madison, WI to work for Epic as a Technical Problem Solver this August. (I actually applied for the job because of a post by Adam Berger on Facebook!) The idea of moving to a new city and living on my own is intimidating, but is a challenge that I'm definitely ready for. I would describe the work that I'll be doing as half-coding, half-consulting, and hopefully I'll get to travel quite a bit for it.

Some people that know me may know that I originally wanted to go to medical school, and I won't get into why I decided to reconsider that, but I will say that I deviated away from the research route after working in a lab one summer and not particularly enjoying it. I think I prefer social interaction and having a faster impact, which is part of why I decided to join Epic.

This is might be some unconventional advice for BioE undergraduates, but I really want to give a ton of credit to my friends for getting me through these past four years. I think it's really important that you find a solid set of friends that you are inspired by. My friends are the people that always guided me to the right path and showed me how I, too, could succeed after college. I am forever indebted to them and the many classes we "struggled" through and the countless nights we spent studying together.

Taking on the design for The Catalyst was one of the best decisions of my undergraduate career. I learned Adobe InDesign for the first time and loved having the creative freedom to build a beautiful product. It has been very cool to see our editorial board expand from what it was when I joined. I think that The Catalyst is very unique within the BioE department because it gives students the opportunity to connect with upperclassmen and faculty, in addition to just being something a little different than research. At the time, I was looking for something more to satisfy my creative juices, and The Catalyst certainly succeeded. I am looking forward to seeing what the next set of designers prepares for the issues to come!

Of course, if you have any questions (about Epic, for instance!), please feel free to reach out to me at: ashlyn@umd.edu

Michael Amorjay-Ogar

Out of the three graduating seniors of The Catalyst, one can refer to me as the new kid on the block. I joined The Catalyst my senior year and have not regretted my decision to do so ever since. Even though I was a transfer from Montgomery College and only spent two years at the University of Maryland, I made sure to utilize my year spent with The Catalyst to the best of my ability. Despite my the short time at UMD, I am pleased to be moving forward with my life by finally reaping the benefits of my hard work throughout my years in college. I will either be working as a Data Scientist for the NSA or as a Healthcare Business Analyst for Inovalon. Throughout my time with The Catalyst, I was able to truly discover my true passion for healthcare and its integration with business, technology, and analytics.

It's honestly been a long time coming, but has definitely been accomplished. My journey towards obtaining my bioengineering degree may vary significantly with most of the current BioE undergraduates. Because of this, I was forced to push myself out of my comfort zone in order to create a network of like-minded individuals in the limited amount of time that I had spent at UMD. So my advice to the BioE undergraduates would be that you all should not be afraid to put yourselves out there. Every experience is an opportunity for you to learn more about yourself and how you can make the best out of your opportunities.

Serving as a staff editor for The Catalyst, I was able to interact with a great number of BioE faculty, students and professionals within the Biotech industry and more. It's amazing to discover the many things that our very own BioE professors are doing within the biomedical field. Apart from the lab research that many conduct on campus, some have even created start-ups within the biotech industry. Alongside with our professors, our students are also doing extraordinary things within academia, research, and the industry. Every student's pathway is different from others, and I have had the pleasure to experience a little bit of their lives simply by interviewing and editing research blurbs of our BioE students. This allowed me to carefully construct my own pathway into the Healthcare Industry. There are many ways one can make an impact on the world's health by utilizing your bioengineering degree, but it is solely up to you and how you decide to embark on this journey.

Adam Berger

I have been a part of The Catalyst since its founding in March of 2014, and I could not be more proud of the progress that we have made over the past few years. I look forward to great things to come in the future. For myself, I will be starting a new journey this summer, joining an MD-PhD program. There, I will learn to do translational research and care for patients. I look forward to this new journey but will miss the Fischell Department of Bioengineering and the great students within. I know they will continue to do awesome things!

My biggest advice for any students is to really aim to think about the real-world applications of theory covered in your classes. For example, in fluids think about the applications of fluids theory in a microfluidic diagnostic device or in a vascular graft. Seeing the applications will help keep you excited and motivated to always work hard. Additionally, it will help you better understand the material. Plus, it will help you discover what you like and what you do not. Both are equally important.

Working on the editorial board of The Catalyst has been an excellent decision. I think what I enjoy most is seeing the journal transform from what we originally proposed to what it now is. It is better than we ever imagined! Additionally, it is exciting to think that the publication we make can help get students interested in undergraduate research. Undergraduate research has been the most important experience of my time at Maryland, and I hope to share this with others. Being a part of The Catalyst has also taught me skills I never thought I would learn. For example, when we needed to do digital design, I stepped up and learned how to do it, eventually serving as the design chair for multiple issues. I also enjoy writing about the research of others, as it is always really interesting to hear what other students are discovering every day. We have awesome students doing awesome things and it is great to highlight my peers. I look forward to seeing where The Catalyst goes in the future. Please feel free to reach out to me at any point if I can be of help to you: agberger@umd.edu

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!

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