



THE CATALYST

LESSONS
FROM
ENTREPRENEURS

THINKING ABOUT
WORKING FOR INDUSTRY?

University of Maryland's Undergraduate
Bioengineering Research Journal

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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 seventh issue coming this Summer 2017! 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?

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Dear Catalyst Readers,

Welcome to the sixth issue of The Catalyst, University of Maryland's Undergraduate Bioengineering Research Journal. Over the past few years, we have been expanding the journal in terms of content and design. Our sixth edition includes 15 outstanding articles; by far the most jam-packed issue yet! With each new edition, The Catalyst has proved to be more than solely a research journal. While our sixth edition does include a lot of pieces showcasing the research done by our undergraduates, it also includes many more articles aimed at encouraging students to pursue research and professor interviews that provide career path insight. I can proudly say it also includes two new sections; an Entrepreneurship section and an Academia vs Industry section. The addition of these two new sections is very exciting because it goes beyond the standard "tell us about what you did" questions. Instead, it goes into further details that will hopefully help students make a decisive decision when faced with a dilemma as to what path to pursue, or guide them when they want to embark on a business venture.

Megan Dang, Caroline Dong, Lauren Jokl, Casey Lim, Angelina Nou, and Reuven

Rosen have contributed research blurbs that give a succinct overview of their research projects and the instrumental roles they have had in carrying out the projects.

With our Professor Interviews section, we wanted it to be more geared towards the professor's lab. While questions about their career path are still asked, readers will see that a large part of the interview will focus on the type of research that is being done, and most importantly, what types of projects undergraduates have been involved in. We hope that the one-on-one interviews with Dr. Silvina Matysiak, Dr. Silvia Muro, and Dr. Ryan Sochol will give readers a more in depth perspective of the research that goes on in each of the professor's lab, and we encourage readers to utilize their valuable advice!

During their college career, many bioengineers will inevitably have to make the decision of either entering academia or industry. With our Academia vs Industry section, we hope to alleviate this decision making-process. Students can read the experiences of fellow bioengineers who have held internships in both academic and industrial settings. Valerie Gupta, Tim Holzberg, and Janna Wisniewski give us insight into the differences between both, and share with us how they decided which path to pursue.

The Entrepreneurship section aims to inform and educate readers of the various aspects of start-up culture. Meenu Singh, from the Academy of Innovation and Entrepreneurship, gives readers vital information to consider when first coming up with a business. She explains design thinking and provides tips for group dynamics. Professor Babak Akhlaghi, of the Legal Aspects of Entrepreneurship course, utilizes his expertise as a practicing patent attorney to answer critical questions about the patent process. His interview teaches readers the necessary steps that need to be taken to ensure Intellectual Property is protected. Our last article showcases the journey taken by UMD bioengineering student Tajbik Shiekh and his partner Haseeb Akhtar to successfully launch their start-up Aceso Care. The co-founders not only tell us how they developed their business but also give words of guidance for aspiring entrepreneurs.

It's quite amazing how far we have come. Having been a part of the team since my freshman year, it's definitely rewarding being able to lead the team during my junior year. Each publication, our design becomes more outstanding and our pieces hit more topics. With such a wide variety of content, our journal becomes more relatable to UMD's bioengineering students, who have diverse interests. This semester's publication turned out great, and it would not be possible without the wonderful editorial board. Turn to the back and take a look at the hard working students who made this possible! Thank you editorial board. Also, thank you Catalyst readers for taking the time to read through our journal. We hope you enjoy it.

Sincerely,

Havisha Garimella, The Catalyst Editor-in-Chief

Get Out of the Lab (and Other Startup Lessons from the Front Lines)

By Sean Virgile, Guest Contributor



In 2012, I co-founded Diagnostic anSERS (DA) as a second-year graduate student to help commercialize an invention out of Prof. White's research lab. We've made countless mistakes, pivoted a number of times, and somehow managed to survive when 90% of all startups fail. Use these lessons to learn how to start your own company as I tell you the story of mine.

Lesson #1: Your science does NOT matter.

Imagine you have a mouse problem. So you go to the store to buy a mouse trap. Does it matter whether it's a traditional spring-loaded mousetrap, the one designed like the "Mouse Trap" board game, or a cat? No, as long as it gets rid of the mice (and you're not allergic to cats), you wouldn't really care. The same principle applies to your customers; they don't care how your product solves their problem, only that it solves their problem.

Don't get me wrong. The science is incredibly important. A scientific breakthrough is what solves the Iron Triangle (Better, Faster, Cheaper-Pick two). It is what opens up a new market and solves a previously unsolvable problem. Your science (and patents) are incredibly important to you and the scientific community, but to your everyday customers, it's just another black box.

So, what about our technology? Well, I'm glad you asked. First, we make gold and silver nanoparticles that we turn into an ink to put into an ink-jet printer. We then print the nanoparticles onto paper. By pipetting an analyte onto the nanoparticle region and then interrogating that region with a Raman spectrometer, the nanoparticles increase the number of photons hitting the analyte. The analyte absorbs the energy from the photons and a small fraction are released at a different wavelength. This collective change in wavelength, or Raman shift, provides a unique spectra, while the nanoparticles increase the size of the spectra approximately six orders of magnitude. Bored yet? Exactly. Just like most of you reading this, our first customer didn't care how our technology worked, only that it solved their problem-measuring small amounts of an analyte, quickly. For them, our technology allowed them to make this measurement both where it mattered most-in the field, instead of in the lab-and in seconds, rather than over half an hour. After visiting the lab and testing the technology, they pledged to buy \$1M after we scaled up production, in the first year alone. At this point, we incorporated, licensed the patent from UMD, and received a grant to scale up manufacturing. (Thank you, TEDCO!)

Lesson #2: Get out of the lab.

After we scaled up, our first customer went bankrupt. What next? We knew our sensors could detect a wide variety of chemicals and had tested everything from pesticides, insecticides, and antibiotics to illicit drugs and explosives. But the lab is not where our customers are. We had to go out and find a new problem to solve. We met with everyone we could. From non-profits interested in pesticide exposure to doctors and nurses concerned about synthetic marijuana, we could not find a market. Our solution was either too expensive or not needed, until we met Chief Mitchell, UMPD's Chief of Police. He told us the police desperately and immediately needed two things: (1) a roadside marijuana test for drivers and (2) an on-site gun-shot residue (GSR) test. Both problems sounded like something we could solve, but we were not sure. Only then did we go back to the lab. So, we bought some THC (legally) and went to the shooting range. The GSR test did not work, but the THC did.

To commercialize a research project or invention, you must build something that solves a problem. And you're not going to find that problem in the lab. It only exists outside, in the real world. You have to interview your customers to understand their pain points, why they have that problem, and what solving that problem means to them both financially and emotionally. If we did not interview prospective customers, we might be building a saliva drug test for hospitals or a chemical test for the TSA, both of which would face too much market competition and would not meet the needs of our target consumer. Interviewing customers prevents you from building a product nobody will buy. By interviewing police and researchers in the US and around the world, we are confident that when we finish developing the roadside marijuana test, the customer will be there; we will not have to cross our fingers and hope they show up.

Lesson #3: Networking brings "luck".

Do not be afraid to talk about your technology or idea. So much of what has shaped DA has been because of who we've met at networking events, here at UMD, and at academic conferences. The sheer number of referrals has not only brought us markets we never knew existed, such as heroin and fentanyl detection in the field, but has also confirmed that we are on the right track.

I'm sorry but this story must end on a cliffhanger. There is no end, yet. Our roadside marijuana test is still in development. We have not made a billion dollars. But entrepreneurship is not about the ending. It's about the journey. So, if you want to start a company or explore entrepreneurship, whether or not you are a researcher in a lab, go outside, explore, and talk to everyone you meet to find the problem.



THE STARTUP THAT AIMS TO TREAT MENTAL HEALTH IN DEVELOPING COUNTRIES

by Havisha Garimella, Editor-in-Chief

Company website: aceso.care
Blog: lucidtech.me

While most of his peers prepare to embark on a career path, Tajbik Shiekh has already paved his own path and has gotten a head start. Ten months ago, Tajbik, a junior bioengineering major, teamed up with Haseeb Akhtar, an alumni of Boston College, to launch their start-up Aceso Care. This is what Tajbik had to say about Aceso Care:

“It’s a healthcare company that focuses on biotech, specifically biotech that allows us to provide gold standard healthcare at the \$3 poverty level. Right now we are geared to providing healthcare in the developing nations at the same standard you would find in a middle class suburb in America, at a price that is also affordable for people living at a pretty low level... So the device that we are pioneering our efforts [towards] right now is a TDCS device (transcranial direct current stimulation), [which is a] non-invasive stimulation device that sends electrical currents to certain areas of the brain to stimulate a chemical response, a change in blood flow.”

Their TDCS device will be used to “to elicit medicinal level effects for treatment resistant stroke patients, anxiety patients, depression patients, and schizophrenia patients.” How it works is electrodes are placed on particular regions of the head using the 10/20 brain map, which a map that outlines the various regions of the brain and their function. Placement is dependent on what the patient wants treatment for, be it anxiety, depression, etc. Their TDCS device is coupled with imaging capabilities. They utilize EIT (electrical impedance tomography) which “uses electrical impedance, a measure of change in voltage between two points at certain frequency, usually around the 10 kilohertz range. We use that to provide spatial resolution and actual imaging as opposed to sinusoidal waves. We are providing images of activity of the brain and at the same time we are stimulating the brain. We are putting this all together and attempting right now to put it together in a machine learning algorithm which simulates each individual’s brain based off their basal brain activity.”

Their device is not without some merit. A few months ago, Haseeb traveled to Pakistan to test the validity of their device. At the clinic, they treated 70 patients with stroke, anxiety, depression and schizophrenia. Video testimonials on Aceso Care’s web page show that patients really saw improvements after undergoing treatment using the TDCS device. Haseeb remembers one patient in particular who has schizophrenia. “When she walked in, you could see on her face she was stressed out; she said she heard voices in her head and can’t stop them.” After just one session, her husband came the next day to thank them because his wife was feeling so much better. She came for the next 15 days to complete treatment. Due to neuroplasticity, after 15-20 days of treatment with TDCS, the effects can be permanent. Those concerned about the safety of the device should know it is safe to use. Through various scientific papers published, the biggest side effect that scientists and doctors found in clinical trials were that patients experienced a headache.



Tajbik Shiekh

I had the opportunity to sit down with the two founders and hear more about their device and start-up. How did this idea come about? Why it is so concerning when medications are available? Haseeb and Tajbik informed us of the issues:

HASEEB	“The biggest gap we are filling in the developing world is some people have schizophrenia, some have depression, some have anxiety but everyone gets Xanax. Everybody gets the same medication.”
TAJBK	“The biggest problem in the developing nations is that a lot of these pharmaceutical companies are giving doctors commission. It is harder to do it state side because of regulation, but overseas doctors get paid by how much they prescribe and what medicine they prescribe. So they make a premium off prescribing medication. [Using TDCS] is also an ethical way to make sure people aren’t getting overprescribed or wrongly prescribed... At the forefront of our efforts is this one device because mental health is something that is not well treated in an appropriate structure in developing nations.”

Aceso Care’s current target market is treatment-resistant patients. Medications have been ineffective for these patients. TDCS has shown, through testing at the clinic, that immediate effects can be seen about 15 days after. The most beneficial, and even competitive advantage, of the TDCS device is the EIT imaging. This is because “in a village you don’t have access to an MRI machine, you don’t have access to a CT scan.” With EIT imaging, all that is required is a computer and the TDCS device to view brain activity.

Their efforts are now geared towards starting a clinic in Pakistan that will see and treat patients regularly with Aceso Care’s technology. Next semester, Tajbik and Haseeb will also travel overseas to launch their headquarters.

As the interview came to an end, Tajbik and Haseeb offered some motivational advice for students who want to pursue entrepreneurship:

HASEEB	“The biggest [problem] you have in college campuses is people don’t get out of their sector. You have kids in bioengineering, [but] they aren’t [connecting] with marketing kids. The biggest advantage you have is just getting [out] of your comfort zone and finding people.”
TAJBK	“We don’t think anything is unachievable or unreachable. People don’t understand you don’t need to apply through a competition, you don’t need to apply through connections. You can literally email anyone and they might not respond but they might respond. These things that seem big and huge, they are right here. This was a difficult journey, it was a lot of work, it consumes hours and hours and detracts from homework, studying, and a social life. If you want to do something like this, there are sacrifices but everyone thinks you have to be like 28 years old with a PhD and dissertation in some advanced topic in bioengineering to make a change. It’s not anyone’s fault but the mindset is too small. The mindset is ‘I’m not big enough’, ‘I don’t have the resources to do it.’ You don’t need the resources; the resources are in your head. Get up and just do it. If you can dream it, if you can think of it, then do it.”



Haseeb Akhtar

YOUR LEGAL QUESTIONS, ANSWERED.

Interview with Mr. Babak Akhlaghi
by Havisha Garimella, Editor-in-Chief

Bioengineering majors often times have various ideas and projects from working in the lab or from their class; however, they do not know where to start. What are some of the first steps they should take?

First thing is that they should protect their idea. To protect their idea, they can do that by filing a patent application. I say this for several reasons. We are on a first to file system; the sooner they get a filing date, the more likely they will beat other people that may come up with the same idea. So, you want to avoid other people coming up with the idea and rushing to the patent office and getting an earlier filing. Second reason is public disclosure of invention. For instance, disclosing to investors may result in the loss of IP rights. In the U.S., our patent system grants the inventor one year from public disclosure to file a patent application. The third reason to file a patent application is because the first question investors would ask is if you have an IP. They are hesitant to invest in ideas that can be easily copied, and that is the purpose of a patent: to exclude others from copying your ideas. Lastly, filing a patent application helps the inventor with the pitch to the investors because part of the job of a patent attorney is to help the inventor solidify their idea and think about all the variations and questions that an investor will ask. Once it has been drafted, it will provide a nice story. This will allow investors to easily understand the invention. It is better to file a patent application first before disclosing.

PUBLIC DISCLOSURE:

If the inventor discloses the invention before the patent application is filed, the inventor will still be able to get a patent as long as the publication/disclosure of the invention is within a one-year period of the filing of the application.

Can a patent be filed for an idea or do you need a working prototype?

A patent can be filed for an idea. The statute requires a specification, drawing, and a claim. You do not need to have to actually build the product to get protection. All you need is a written description and enabling disclosure so somebody who has the resources can use the specifications and drawing to make it. There is no requirement for having to build the product to get the protection.

ENABLING DISCLOSURE:

Enough information must be given/disclosed in the patent application to allow/enable a person who is skilled in that field to carry out the invention.

You mentioned that you should have enabling disclosure and specifications in the patent application, so someone in the art can make the prototype. If you filed the patent for the idea, does that guarantee you to build the prototype or does it allow others to build the prototype with the idea?

Patents give the patent owner exclusive rights, but these exclusive rights are negative rights. It gives authority to patent owners to exclude others from making or selling using the patent of the invention. So, once you disclose, no one else can make, use, or sell your patent unless you license it to them or sell it to them. The standard for specification (for patent application) is that it has to provide enough information ("enabling disclosure") so that somebody with the skill in the art can make it, but it doesn't authorize that person to make it. In order to get that authorization, you have to seek the permission of the patent owner. Not anyone can go ahead and make it.



Mr. Babak Akhlaghi is a professor of the Legal Aspects of Entrepreneurship class and he is a practicing patent attorney. After graduating magna cum laude with an electrical engineering degree from University of Maryland, he attended University of Houston Law Center graduating cum laude and now is a managing partner in the law firm of NovoTechIP International PLLC located in Washington, D.C. office. He focuses his practice on patents, trademarks, and copyrights with a particular focus on patent prosecution, reexamination, freedom-to-operate investigation, opinion work, and licensing.

Usually, there are many different labs researching the same or similar topics. In those scenarios, what determines who will have rights to the IP?

It happens a lot, especially for those in the research field - people concurrently come up with the same idea. Who is entitled to the patent right, especially when working independently from each other? The answer is, whoever files the patent application first is entitled to the application. It does not matter who invents it first, only who files first, but whoever files should be the inventor.

There is no guarantee that the idea filed for a patent will actually work. So, do you have to conduct some sort of prior tests to show that the inventive steps will yield the outcome?

If someone makes the invention, but it does not produce the intended result, that is okay - that is not the standard. The standard is making the invention. For example, if you say that you will make this pill that has these combinations and will cure cancer, but you find out that it does not cure cancer, again, that combination can be novel, but it is just a useless pill. The standard of patentability is written description and enabling disclosure, but the final result that is being produced is not tested by the USPTO.

When should inventors contact a lawyer?

I think the wise thing to do is to contact a lawyer before they publicly disclose the invention; the sooner the better. We are under a first to file system. The sooner they talk to an attorney, the sooner they can draft a patent application. The process can take 30 to 60 days.

Why would LLC be the most beneficial for startups?

One of key advantages of an LLC is limited liability protection. What that means is that it shields the founders of the company from liability beyond the assets of the company. So, if something goes wrong, only the assets of company are at stake, not the personal assets of the owners and shareholders. Also, an LLC is easy to set up; it requires an Article of Incorporation and an Operating Agreement. Most of these forms can be found online, but a lawyer should look through making sure all the aspects are covered. Another reason is that it is more prestigious to approach an investor if they are approaching on behalf of a company than if approaching as an individual inventor.

Q: What is the Academy of Innovation and Entrepreneurship's goal?

A: AIE wants to engage all UMD students in innovation, mainly through classes. It promotes design thinking and lean startups, and one of the biggest misconceptions about AIE is that all students have to start up cool ideas on their own.

Q: What advice do you have for students getting too locked into design thinking?

A: To take a step back and see that the problem they're trying to solve is actually a problem. Design thinking in a bioengineering setting is looking at the human body and how to use engineering to make it work better. If you take care to learn about people and the impact your design could have, for example by observing a hospital setting, that's the difference between problem solving and design thinking.

Q: What tactics do you have for bioengineering students looking to explore ideas?

A: Bioengineering is a new field and ever expanding. Students should view themselves as startups and be entrepreneurial in the field, and really think about what value they want to bring. They can do this by considering who they want to serve whether it be an engineering startup, large pharmaceutical company, etc. The path for bioengineering students is different for everyone and that is exciting and students should take advantage of it.

The whole capstone course in bioengineering is centered on the idea of the lean startup. It focuses on scaling a given idea so that it has the maximum customer impact. This is done by taking into consideration everything that could go wrong and also by figuring out who's going to pay for it. A key skill is learning as much as you can from others. This is something that doesn't just validate your ideas but also advances them so that the final product does the best job of solving the problem.



Meenu Singh, a civil engineering alumni of UMD, works at the Academy of Innovation and Entrepreneurship as an Innovation Specialist. She focuses on design-thinking, a methodology that uses creativity, reasoning, and strategic analysis to come up with solutions for problems of interest. The design-thinking process is oftentimes used as the first step before creating.

Q: What resources do you have for students looking to learn more?

A: I really recommend the book *Creative Confidence*, by David and Tom Kelley, which talks about the creative potential we all have. It's a great book to read to find out that you are indeed creative and have been your entire life. I also recommend *The Lean Startup* by Eric Ries. It's about the entrepreneurship of how to scale a product to maximize impact.

As for student organizations, I would suggest looking into the UMD chapter of Design for America, and of course Engineers Without Borders.

Q: How can bioengineering students who are pre-professional benefit from innovation?

A: Students have to realize that they are a startup, and that they have to find ways to convince people that what they're doing is valuable, whether it be research or a certain type of practice. In fact, having a private practice is entrepreneurship. And even if it's not relevant now, I would recommend that students watch out for skills like innovation and entrepreneurship that will help them out a lot in the future to be doctors with empathy, researchers who are more creative, etc.

Q: Do you have any tips for dealing with many ideas in a group?

- A:**
1. Select ideas for potential, not feasibility. Even if there's an idea that initially seems less feasible than another, if there's a lot of energy surrounding it go for it instead of the one that's more feasible.
 2. If there are multiple ideas, try to build things at a low resolution through prototyping. Prototyping makes you able to take the ideas to a user or an expert and get feedback on your ideas. You can let the user decide which idea is going to win. This allows you to start out with multiple ideas and narrow down your potential designs. Even if you just sketch and use really cheap material to build your prototype, you can take that to the user to see what resonates and what falls flat, which is really valuable.

ACADEMY

by Maryam Ghaderi, Staff Editor

of

INNOVATION

ENTREPRENEURSHIP

&

[ft. Meenu Singh]

FACES OF FACULTY:

Dr. Silvina Matysiak

by Justin Sylvers, Staff Editor



Could you give me an overview of your professional path?

I did my undergraduate in Argentina in chemical engineering, then I moved to this country. I got my PhD at Rice in physical chemistry. After finishing my PhD then I went to the University of Texas at Austin for a postdoc, after which I moved here.

Why did you choose the department of bioengineering?

Although the type of research that I did for my PhD was not in bioengineering, it was biologically related. I studied how proteins fold and how misfolding can lead to loss of function. I've always had an interest in biological systems such as this, so bioengineering seemed to be a perfect fit.

Did you predict that you would end up in academia?

I did not do research as an undergrad. It is very uncommon in Argentina for undergrads to do research due to a lack of available resources. So as an undergrad, I had no idea. Since I didn't have this exposure, I thought I would end up in industry. I started my PhD because I had interest in understanding more fundamental science. Halfway through my PhD, I realized academia was a good place for me to stay.

Who was your biggest influence through education?

My PhD advisor. I was her second student, so I saw her building her lab. I was exposed to the whole process. From this, I learned how to think, how to approach a problem. I was amazed at how you could come up

with simple mathematical equations that describe natural phenomena. This is why I ended up doing modeling, a fascination with developing simple theories that can be used to explain the natural world.

Could you give me an overview of the research going on in your lab?

We are a computational lab. We are studying different processes at the molecular level. We are studying biophysical and mechanical properties, for example: lipid bilayers. How, if you start changing different phospholipids, it can give you different mechanical properties in the bilayer. This is important because cells are enclosed in lipid bilayers, and changes in the molecular environment could change the behavior of that layer that keeps everything together in the cell.

We are also studying protein allostery, how intra-protein communication works. For example, you can look at an enzyme with an active site and a regulator site. Depending on what's going on in a metabolic pathway, you may have the presence of a certain type of molecule that may bind to this protein which tells it that it must begin to function. We're trying to understand how having a molecule bound to one part of the protein could transmit information to a region of the protein that is really, really far away. We are using computational tools to understand how this happens. This is relevant, for instance, in the case of pharmaceuticals. When people design drugs, they are trying to change or knock down function of proteins. For this, understanding how protein communication happens is really, really crucial.

We also study protein folding and aggregation. This is relevant to a lot of diseases like Parkinson's and Alzheimer's where you have a protein that, instead of having its nice functional structure, it changes shape and forms fibrils, like muscle fibers.

We're trying to understand how that process happens and how it can be affected by changes in the environment such as changes in lipids or the presence of cholesterol.

In the lab, students do molecular simulations. Some students like to code and others don't. For the ones that don't like coding, they run simulations and focus on the analysis part of the research. Those that like to code get their hands really dirty and do much more theoretical types of research where they may need to modify source codes.

What are the implications of your work in other fields of bioengineering?

The relevance of what we do in the lab is really basic science, so it is not completely translational. What we can do is inform other labs that do wet lab experiments how to do experiments, or sometimes the other way around. I can have colleagues here saying, "I'm observing these behaviors." With modeling, we can provide mechanisms for these observables which have a higher

chance of being true than any hypothesis one could think of. I can show how molecules move, how different things can happen that lead to the observables. Sometimes it goes the other way around. We do simulations and predict outcomes and ask our experimental collaborators to see if they happen in real life.

My work has relevance to molecular research. I could not, say, collaborate with someone working in tissue engineering because it is on too different a scale. They are working on cells and I am working on molecules. However, if someone was, for example, designing a lipid vesicle for drug delivery or designing sensors based on protein binding, I could collaborate with them because they are systems in which molecules are involved.

What do you love about the Fischell Department of Bioengineering?

laughter I really like my colleagues. I would say that it is a very friendly department.

The Matysiak Lab is currently recruiting undergrads! For those interested in learning more, send Dr. Matysiak an email at matysiak@umd.edu explaining your interest in the lab.



FACES OF FACULTY:

Dr. Silvia Muro

Could you give us some insight into your educational and professional career paths?

I am a biologist by training, have been a research assistant professor of Pharmacology in the Medical School, and I am currently an associate professor in Bioengineering. I received my undergraduate degree in sciences, with specialty in biology, from University of Granada in Spain. I then moved to University Autónoma of Madrid, where I got my Ph.D in sciences with a specialty in molecular biology. My dissertation work was on fundamental aspects, which provided me with very good ground of understanding the physiology of the human body at the molecular and biochemical levels, in particular how genetic defects might cause disease. Then, I became interested in conducting research on a more applicable topic – knowing how pathologies develop and what the causes may be. I came to the US after my Ph.D and took a postdoctoral training position in the medical school of the University of Pennsylvania, where I joined a lab working with targeting and drug delivery concepts using nanotechnologies; I got trained in this new field. I then came to UMD to run my lab.

What research does your lab conduct?

My lab works on drug delivery, with a particular focus on achieving precise transport of drug carriers across barriers and cellular compartments. This can be broadly applied to many medicines and diseases, but we mainly focus on delivering biological therapeutics (enzymes, antibodies, siRNA) for the treatment of genetic conditions. Precise and efficient transport, delivery, and effects are particularly limited for biological therapeutics because of their relatively large size, chemical features, susceptibility to inactivation and degradation, and ability to be recognized by the immune system. In fact, one of the [reasons] why we do not have yet efficient treatment for these conditions is not that scientists cannot or have not identified adequate therapeutic molecules, but that these therapeutic molecules cannot be properly delivered in the human body. For instance, some therapeutics may not be soluble in watery fluids, or cannot go in the body to those places where their activity is needed. Because of these problems, the drug delivery field rose to try to bridge the gap between developing a drug and trying to present it properly to the body to enable its maximal therapeutic action.

How do the biological functionalization (of the carriers) help with targeted drug delivery?

Most labs working in this field focus on solving problems described above by developing materials and drug carriers with physical and/or chemical properties and functionalization in order to control the loading, solubility, protection and release of therapeutic drugs. Instead of synthesizing and using new material, my laboratory focuses on providing these drug carriers with biological functionalization. With biological functionalization, the carriers can accumulate in areas of disease in the body by recognizing markers expressed in these regions. They can also induce their active transport across cellular compartments so that a drug can reach its ultimate location for release. Most other drug targeting and transport strategies are designed so that a drug carrier can bind to a selected cellular marker in the body, but what the body or cell does with the bound drug carrier fully depends on the processes naturally associated with that marker and cell. In other words, one can only select a cell marker to which a drug carrier can bind, but then we have no further control and it is up to the cell to mobilize the drug carrier to the cell-desired destination, using

the signaling and transport pathways natural to that cell. Instead, my lab deciphers the biological regulation of these events and incorporates selected regulatory signals in the drug carrier. We impart the said drug carrier control not only over binding to a cellular marker but also control over the signaling, transport events, and destination we need to take place.

Do you have any advice for students wanting to get involved in research? Especially for those who may not have prior research experiences?

The best way to get involved with research is to talk to academic advisors and to look into the research profiles of the faculty on campus (does not have to be restricted to your major). I encourage students to learn about the research that campus faculty are doing, and if interesting to you, talk to the faculty and see if they have room in their labs for you. We understand that your background might be something different and you might not have any previous research experience. In fact, that is precisely the goal; to provide you with new experiences, knowledge, and training for you to explore potential career paths and enable your future opportunities. Whether or not you are interested in research in the future, the lab environment is no different than a workplace: you will learn how to work independently and in teams, you will gain experience about communicating with your supervisor, and you will interact with peers. The experience of working in a real world other than the classroom is valuable.

In the classroom you receive knowledge and are taught how to use that knowledge, but in a research lab you are further trained to apply that knowledge and produce new knowledge. In a research lab you will read the literature and you will integrate what you learn into posing a new question that no one has asked before,

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Dr. Silvia Muro is associate professor in Bioengineering, and her lab's research interests focus on targeted drug delivery using biologically functionalized carriers. She also teaches BIOE340: Modeling Physiological Systems and Lab.

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and you will figure out how to answer that question and how to teach the world the new knowledge you produced (e.g., by participating as an author in conference or writing a scientific paper). This provides independent self-thinking skills and whether or not you work in research in the future, these are valuable skills you will carry with you wherever you go.

What are some projects or skills that undergraduates have gained from working in your lab?

I am always happy to have undergrad students. I have had great experiences with them. Some of my undergrad students have published among the best papers coming from my lab. One must provide undergrad students with the training and resources needed so they can really carry on a project while studying. Undergrad interns may help someone else in the lab or work independently upon proper training, but in any case, I give them ownership and credit in building up something that is meaningful to them. I have had undergrads with previous research experience or without any. In my lab, they can learn how to fabricate polymer nanoparticles, how to functionalize them with biological coatings, and how to characterize certain biophysical properties such as their size and chemical surface. Students also learn, in my lab, how to study the interactions of drug carriers with biological systems, they learn microscopy, image analysis, and statistics. They engage in presenting their work in lab meetings, so they learn how to give presentations orally. I also encourage them to present their data at local symposiums and sometimes at national conferences if their work is good enough. This allows them to present a poster and network with colleagues in the field and potential employers. Often my students get to participate in publications because their work is relevant enough – when this happens, their CV and professional value is highly enhanced because this shows that their products were meaningful.

Manual Lens Stretching Device for Presbyopia

by Caroline Dong, Guest Contributor

The past year and a half, working in the Biotech Optics Lab has been a rewarding experience. When I first met with Dr. Scarcelli, I told him I was more interested in the biology aspect of optics as opposed to the physics side, which is why he presented me with my very first task: recreate cataracts. In less than a month, I was dissecting pig eyes. I never imagined I would be doing these kinds of tasks within such a short period of time, but I began to see what research was like and how rewarding it is.

As I entered sophomore year, I transitioned away from cataracts to what I'm currently working on, which is studying the mechanical properties of the lens as it relates to presbyopia. Presbyopia is an age related eye condition where the lens loses its ability to accommodate, causing us to see objects out of focus. There are currently no active cures for this disease and the only available treatments are corrective lenses or surgery. In order to study the loss of accommodation, I've been measuring how far the lens can stretch by using a manual lens stretching device made by BIONIKO. In order to simulate the accommodation mechanism in the eye, the lens along with the attached zonule fibers are removed from the eye and placed onto the base of the stretching device. Plastic clips are fastened onto the zonules, and are then stretched out, which in turn stretches the lens. Pictures and videos are taken of these two states, stretched and unstretched, and are quantified using ImageJ and MATLAB. Using these programs, we are able to quantify the amount the lens has stretched. This method is repeated many times with porcine lenses and has been used to compare the stretching ability of a young human lenses versus old human lenses.

Doing research was not at all what I expected. At times it can be exciting when there's new data, and other times there are setbacks that can be frustrating. But whenever there are setbacks, there's other students and professors that are willing to work with you to find a solution. Experiencing these things have helped me grow as a student and taught me a lot outside of a classroom setting. There's still much to be improved upon, but I'm very grateful for the experiences I've had so far. What's so rewarding about research is thinking about the impact it will have on people's lives, especially in the case of presbyopia.



Caroline Dong

Being able to better understand a topic that no one has before, or working towards solving a problem that remains unsolved is exciting and benefits not only us, but the lives of others. To the students are interested in getting involved in research, start by finding professors whose work interests you and email them! Professors are often times a lot nicer than they seem, so don't be afraid to reach out to them and ask about their research. A simple email can turn into a great opportunity.

Regenerating Retinal Ganglion Cells

by Angelina Nou, Guest Contributor

My name is Angelina Nou and I have been working with Dr. Giuliano Scarcelli in the Optics Biotech Laboratory since last fall. Right now, I'm researching the biomechanics of the retina. I got started in this project through a rather unexpected manner. Dr. Scarcelli wanted to apply for a grant to regenerate retinal ganglion cells. Retinal ganglion cells are the cells that are destroyed during glaucoma, leading to blindness. He asked me to culture some of these cells for him in order to conduct some simple experiments. As I did not know anything about the retina at this point, I read a lot of literature in order to understand the general theory behind our project and to find specific protocols to follow. In doing so, I learned that the retina is really cool, and decided to keep working on this project.

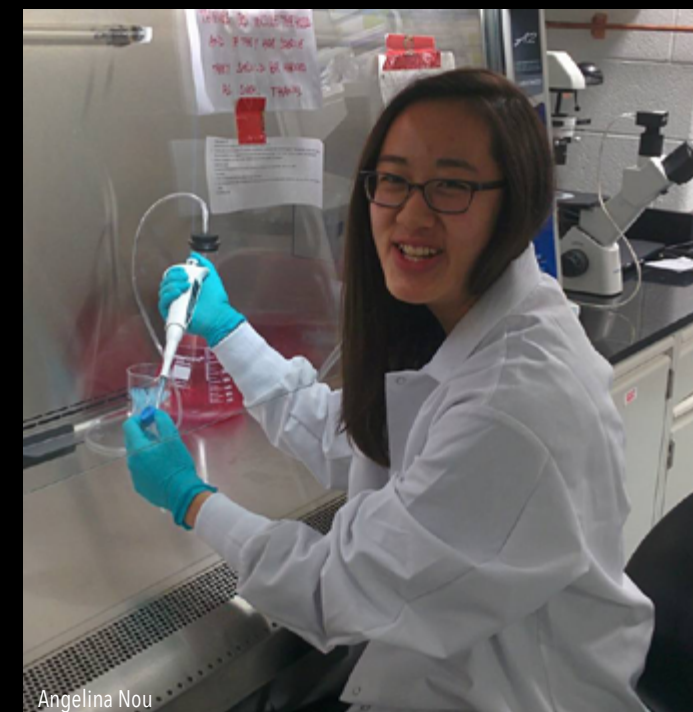
The retina is the layer of cells at the back of your eye that detects photons and transmits this information to the brain, via the optic nerve. The retina is actually considered a part of the central nervous system, so

studying the retina is not only relevant to specific diseases like glaucoma, but also can help us understand how other neurons in the central nervous system function. The focus of the grant was to study how to regenerate retinal ganglion cells, the innermost layer of cells in the retina and the ones that merge into the optic nerve. Regenerating the retinal ganglion cell layer is very challenging for a number of reasons. Because these are neuronal cells, they are very fragile and do not grow or divide as adult cells, so to regenerate the retinal ganglion cell layer, scientists have tried transplanting stem cells or retinal progenitor cells. However, this leaves us with the problem of how to direct cell differentiation down the retinal ganglion cell lineage. In addition, the retinal ganglion cells have to synapse with the other neurons in the retina that they receive signals from, and extend an axon across the eye and down the optic nerve (the optic nerve is just a bundle of retinal ganglion cell axons). Regulation of this process is complicated.

The inspiration for our research stems from the fact that the challenges facing regeneration are all processes that occur naturally in the embryo during retinogenesis and early retinal maturation. Hence, if we can understand some of the changes between the embryonic retina and adult retina, we might be able to use this knowledge to improve cell viability, differentiation, synaptogenesis, and axonogenesis. Most research studying retinal development has been centered around changes in gene expression or different signaling cascades, which, though important, are only part of the story. The retina and the individual cells within it exist in an environment richly saturated with mechanical cues that shift over the course of development. For example, the retina experiences tension as the eye grows and intraocular pressure from the fluid within the eye. In fact, the major factor associated with glaucoma is elevated intraocular pressure. During development, the retina tissue changes a lot, as cells migrate and differentiate constantly to form the static, stratified structure that is a mature retina. As a whole, people are beginning to recognize that cells are also physical objects and thus studying cellular biomechanics. There have been some really nifty pioneering studies that have looked at how neurons are sensitive to mechanical cues, so we think there's a lot of promise in studying the biomechanics of the retina.

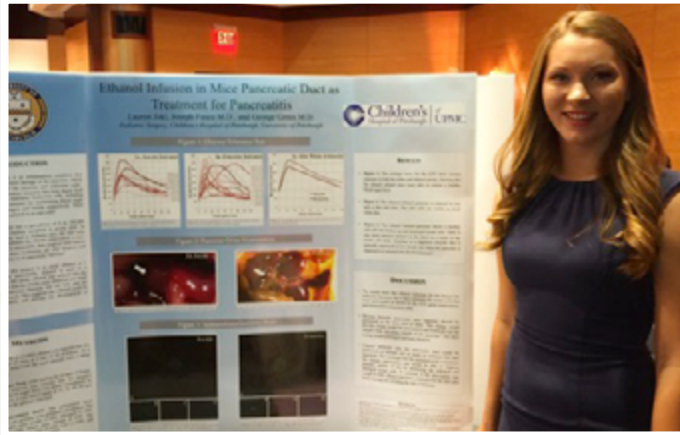
Our lab is uniquely equipped to study biomechanics. The most commonly used techniques in this field include atomic force microscopy and micropipette aspiration, in which a known external force is applied to the cell and the deformation is measured. These techniques are imperfect approximations because we can't know if disturbing the cells changes anything. They are also pretty slow, don't have great resolution, and are limited to the two-dimensional plane. We specialize in a novel technology called Brillouin microscopy, which allows us to measure the mechanical properties of our sample without contact, using only

light. This principle relies on a phenomenon known as Brillouin light scattering. Essentially, when light passes through a material, it can interact with acoustic phonons in the sample, which are related the moduli of the material. The phonons are basically packets of energy, so they'll shift the frequency of the light by a certain amount. We measure this frequency shift pixel by pixel, and from this, we can map the mechanical properties of the sample. This is a much faster, more direct, and less invasive way to measure the stiffness of cells, and works in both the XY and XZ planes. I am using Brillouin microscopy to study both the retina tissue and retinal ganglion cells. We want to see how the structure of the entire tissue changes over time, as well as how individual cells change on different mechanical substrates.



Angelina Nou

This experience has been and continues to be both one of the most challenging and rewarding commitments I've made in college. I have had a lot of independence in this project, which has made this experience really unique. It also comes with a lot of responsibility, so I think I've pushed myself a lot harder to do well with this research and thus learned a lot. Pretty much all of the theoretical framework and any experimental procedures I pieced together by reviewing the literature and just reading as much as possible, so much so that I'm surprised by how much my problem-solving and critical analysis skills have grown. Dr. Scarcelli is also an incredibly supportive mentor, and even though he lets me figure most things out on my own, he's always been there to help me get back on track when I'm stuck. Balancing research with my other commitments is difficult, but when I reflect on all of the skills -technical skills and soft skills- that I've picked up working in this lab, as well as all of the wonderful people I've gotten to meet, I am convinced that it is worthwhile.



Ethanol Infusion in Mice Pancreatic Duct as Treatment for Pancreatitis

by Lauren Jokl, Guest Contributor

I am currently a senior bioengineering student at UMD and last summer I had the opportunity to return to my hometown and be a part of the Children's Hospital of Pittsburgh (CHP) Summer Research Internship Program. I spent eight weeks working in Dr. George Gittes's lab in the department of Pediatric Surgery. Dr. Gittes is the Surgeon-in-Chief, Chair of Pediatric Surgery, and the Director of Pediatric Surgical Research at CHP. Within his lab, I was under the mentoring of Dr. Joseph Fusco where I studied a potential treatment for chronic pancreatitis.

Chronic pancreatitis is an inflammatory condition that results in permanent structural damage of the pancreas, which leads to functional loss of the exocrine and endocrine cells. Exocrine cells produce enzymes that help digest food and are referred to as acinar cells, which is what pancreatitis affects. Endocrine cells produce hormones that regulate blood sugar levels. Endocrine cells include α cells, which make glucagon, and β cells, which make insulin. These cells are co-localized and referred to as islet cells.

Chronic pancreatitis has a prevalence of 8 in 100,000 people and the most common symptom is abdominal pain. In addition, it can frequently lead to diabetes once the islet cells are destroyed. The initial treatment for chronic pancreatitis is non-operative, but if the pain is intractable then surgical intervention is required. However, these treatments are very invasive and leave the patient with little to no pancreatic function.

The purpose of my research was to study ethanol, which is a common denaturing fixative, as a potential treatment for pancreatitis. In this study, ethanol was infused into the pancreatic duct of mice and the results were observed one week post injection. The theory is that the islet cells will not be affected, but the acinar cells will be destroyed.

Ethanol was administered to the islet and acinar cells by injecting 100% ethanol into the pancreatic duct of mice. One week post injection, I conducted glucose tolerance tests to assess the pancreatic function. In addition, I took pictures and stained samples to examine the islet and acinar cells. These tests were also performed on control mice that underwent saline solution injections in order to make accurate conclusions.

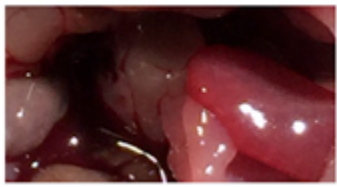
The results showed that the islet cells were preserved, but the acinar cells were destroyed. Correspondingly, amylase was present in the ducts after the ethanol injection. Amylase is a digestive enzyme that is normally expressed at low levels unless the pancreas is impaired. The glucose tolerance tests showed that the ethanol infused mice were able to restore normal blood sugar levels similarly to the saline infused mice.

These results show that ethanol infusions do not impact the endocrine function, but it does eliminate the acinar cells that cause pancreatitis as shown by the GTT, gross examination, and immunohistochemistry stain. Moving forward, pancreatic duct ligations should be performed in the next trial of mice. This change would provide a better model for pancreatitis and would prevent the ethanol from spreading outside of the pancreas. The mice testing should be prolonged and more frequent. Ethanol infusions into the pancreatic duct could be performed on humans just as easily as common bile duct injection. The technique has the potential to be a treatment for chronic pancreatitis and would be able to improve patients' quality of life by destroying the inflamed and damaged acinar cells. In addition, if the pancreatitis was caught in time, ethanol injections could prevent the islets cells from burning out, avoiding the risk of diabetes.

From this experience I learned how to conduct research, work with animal subjects, perform various laboratory techniques, and use common lab equipment. In addition, I was able to shadow in CHP, where I observed surgeries, live births, and emergency medicine. At the conclusion of the eight weeks I presented my findings at a poster session. This experience as a whole was very rewarding and it helped give me direction for my future career as a bioengineer. I advise other undergraduate students to get involved in research by putting themselves out there and reaching out to professors and doctors that are conducting research. Ask lots of questions and try to learn something new every day!



▲ Ethanol



▲ Saline

Detecting Methotrexate on Paper Diagnostic Sensors

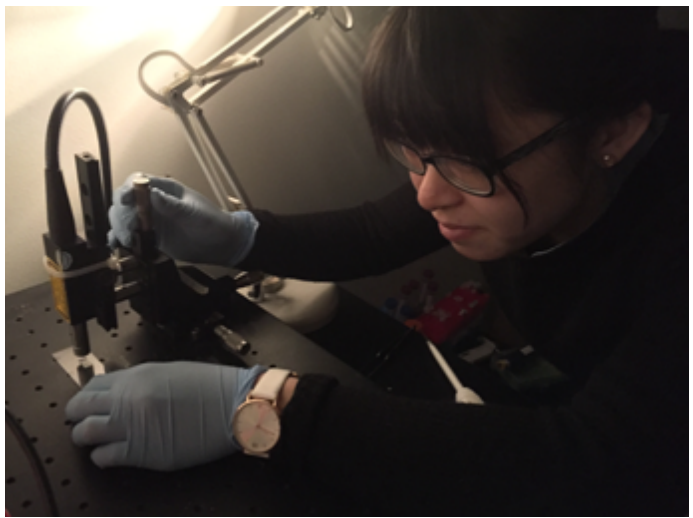
by Megan Dang, Guest Contributor

Currently, advanced biosensing technologies are available in laboratories which are capable of providing diagnostics for various fields. This includes diagnostics for diseases, food, water, and more. Despite the precision of the diagnostic platforms and devices, there are many disadvantages. Such technology is typically composed of many integrating components and is only found within a laboratory. As a result, if a diagnosis is needed, samples need to be transported to a laboratory and then tested, which does not yield immediate results.

I decided to work in the Amplified Molecular Sensors Lab with Dr. White due to the lab's focus on diagnostics. Previously, I was a Pathways Intern at the National Institute of Health in an Animal Diagnostics Lab. I ran assays to diagnose bacteria in animals, which were part of other research projects at NIH. My lab experience and background in assays opened up a door for me with Dr. White. Currently, the White Research Group aims to create a diagnostic assay that would be able to provide onsite results at the time and location required. At the moment, samples of patients are being taken onsite. However, the samples then are transported to laboratories, which require large diagnostic devices to run the sample. Typically, doctors will have to wait for a few days for the results of the patient's samples. Ideally, an assay would give a diagnostic within a single step in addition to being low cost.

Therapeutic drug monitoring (TDM) is the clinical practice of measuring specific drugs at designated intervals in order to maintain a constant concentration in the patient's bloodstream. This practice is done in order to optimize the dosage administered to the patients. However, TDM requires advanced technology and time in order to provide an accurate result. In the White Research Lab, we are focusing on the alternative technology of surface enhanced Raman spectroscopy (SERS), which provides an enhanced Raman signal from compatible analyte molecules that have interacted with metal surfaces. Raman spectroscopy consists of a laser that is pointed towards the analyte on a metal surface. The interaction of the laser, goes through Raman scattering, which is the molecular vibrations through inelastic scattering. This provides a clear spectra that can be confidently interpreted to be a specific analyte. I am currently working with a chemotherapeutic drug, methotrexate, and SERS substrates that are fabricated by inkjet printing of silver nanoparticles onto paper.

Currently, I am trying to optimize the signal of methotrexate. To do so, I'm allowing the methotrexate to interact with silver nanoparticles that have been printed onto paper strips. One of the variables I am trying to optimize is the interaction time between the methotrexate and silver nanoparticles. In my initial experiments, I noticed that the samples that had longer interaction resulted in a more highly amplified signal. To confirm this, I am planning a time study experiment so that I can determine a set interaction time for methotrexate incubation with the silver nanoparticles. In general, the long-term goal of my project is to detect the signal of methotrexate in serum and whole blood. This introduces other components and particulates that need to be filtered out so that there aren't any interferences with the signals.



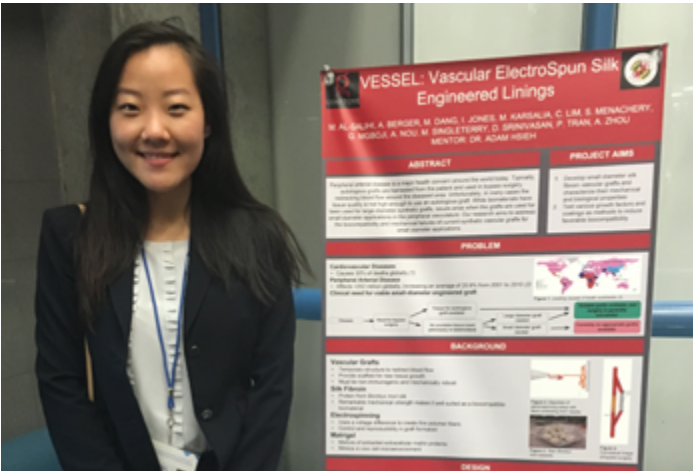
Something that I learned from working in the Amplified Molecular Sensors Lab is that you don't necessarily need the most sophisticated technology in order to conduct your research. For example, I use a simple inkjet printer that was deconstructed and modified for specific functions. After synthesizing the silver nanoparticles, propylene glycol is added in order to adjust the silver nanoparticle ink to its ideal viscosity. Following this, the sensors are printed just like normal documents on paper. The idea is that this method allows for a user-friendly self-diagnosis.

I have learned a lot from my time working in Dr. White's lab. Not only have I gained hands-on lab experience, I've gotten insightful advice from the graduate students with whom I work. My advice to any students interested in research is to put themselves out there early on. Afterwards, make the most out of the experience and get to know your PI and the graduate students. Everyone is willing to talk through your research project and career plans, but you have to put in the effort and show the willingness and interest to learn.

A Winding Road to Tissue Engineering
by Casey Lim, Guest Contributor

While seemingly direct, my path to biomedical research has been decidedly circuitous. I resolved at a young age to become a physician-scientist, but as I grew up I found that I was passionate about a lot of different subjects. From attending a math camp, to taking a computational programming class in middle school, to stepping into my first biology research lab for a science fair project on astrocytes, I was determined to explore my varied interests. I first discovered bioinformatics through an internship at the Johns Hopkins McKusick-Nathans Institute of Genetic Medicine, and it resonated with my desire to combine my passions. It was my first introduction to the world of biomedical engineering, and I was hooked. I found that biomedical engineering combined my penchant for scientific reasoning with a medical application while also allowing for creativity in problem solving.

Coming to UMD I knew that I wanted work with research that I had never experienced before. I previously interned in a bioinformatics laboratory working with code to develop an RNA sequencing program, a cancer research laboratory working with on oncogenes with zebrafish, and a radiology department analyzing MRI scans. While I enjoyed all of these experiences, I wanted to find a field that I was truly passionate about. During my freshman year, I emailed Dr. Fisher to find out if I could be an undergraduate researcher in the Tissue Engineering and Biomaterials Laboratory. He emailed me back to say that unfortunately they weren't accepting applications at this time and to maybe try again in the future. Fortunately for me, I contacted Dr. Fisher again the summer after my freshman year and in the next week started working with Ting Guo, a graduate student in his laboratory.



As I had hoped, tissue engineering provided an entirely new and exciting field of skills and problems to think about. My first project was related to demonstrating the impact of compressive force on the differentiation of human mesenchymal stem cells (hMSCs) in a bioreactor system. We developed a bioreactor system that applies shear and compressive force to hMSCs encapsulated in alginate beads. Our results suggested that this combination of mechanical stimulation would promote the differentiation and culture of hMSCs which is important for clinical treatment of articular cartilage defects.

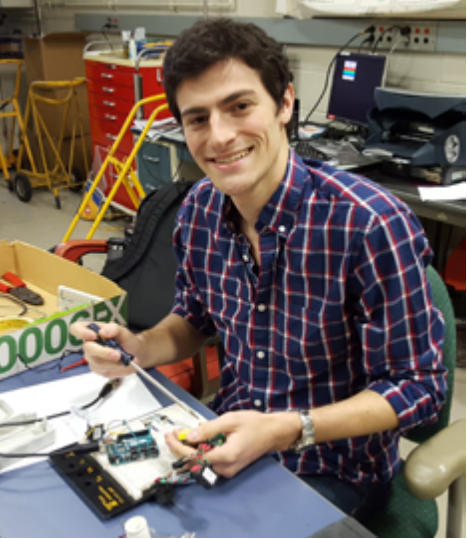
My current research looks in an entirely new direction: the use of 3-D printing for treatment of articular cartilage defects. Articular cartilage defects in knee joints are often the result of trauma or prolonged and increasing stress over time. Depending on the size of the lesions, the cartilage has limited self-regenerative ability because it lacks proper supply of nutrients from blood and lymph vessels. Current surgical methods for cartilage repair are limited in mimicking native cartilage as the cartilage that is formed is commonly very fibrous and tends to deteriorate. In order to achieve more efficient cartilage regeneration, we are developing a 3-D printed natural polymer scaffold to treat articular cartilage defects. More specifically, layers of the scaffold will vary in polymer composition corresponding to the various zones of native cartilage, better mimicking native cartilage. The long term goal of this research project is to develop a 3-D printed polymer scaffold capturing the native cartilage properties that can be customized to articular cartilage defects and improve patient recovery time. I am currently working to complete this research and defend my honors thesis on this work in the spring of 2017.

My two years of being a part of the Tissue Engineering and Biomaterials Laboratory has been one of the most fulfilling parts of my time at UMD. I have been challenged to learn and grow in and outside of the lab, and I have benefitted from amazing mentors and teammates. These experiences have reinforced my passion in biomedical research and my resolve to continue with research as a physician in the future.

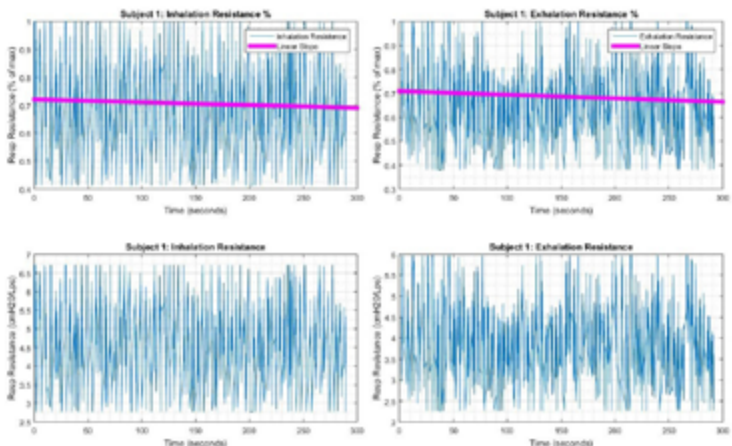


Respiratory Resistance Control Using Biofeedback Techniques
by Reuven Rosen, Guest Contributor

Since the beginning of my sophomore year, I have worked in the Human Performance Laboratory on campus to help develop the Airflow Perturbation Device (APD). The APD is a small hand-held device capable of measuring respiratory resistance, a parameter used to gauge the effectiveness of a breathe. My interest in respiratory function testing initially unfolded from



spending numerous nights in the hospital with my asthmatic brother. His home-based treatments were often insufficient to maintain an open airway, so he would require advanced therapies to breathe. I was interested in getting involved with research on campus and came across the Human Performance Laboratory. After years of observing the effects of asthma, I instantly jumped at the opportunity to take an active role in asthmatic therapy. I reached out to the head of the laboratory, Dr. Arthur Johnson, and worked with him to develop my research project. I tailored my work towards developing a supplemental treatment to prescribed medications and reduce the need for additional clinically administered pharmacological interventions.



My main focus in the laboratory is to integrate biofeedback capabilities into the APD. Biofeedback is the utilization of a signal from the body, i.e. some form of physiological measurement such as a heart rate or temperature, to improve one's health. Biofeedback has been used in the past to treat asthma, upper airway diseases, anxiety, and many other psychological and physiological diseases. The theory behind my project is that the external signal from the APD, i.e. respiratory resistance, can be used for biofeedback purposes to supplement respiratory therapies. The current model of the APD measures a patient's average respiratory resistance after assessing multiple data points over a sixty second interval. However, in order to provide viable biofeedback capabilities, the system must return resistance values in real time. Therefore, my focus has been upgrading the APD's software and hardware to rapidly expedite its data acquisition. To do so, I use MATLAB to process data from two pressure transducers and a flow meter to efficiently measure respiratory resistance. A small wheel rotates around the airflow channel, temporarily perturbing the flow, and allowing for the near-simultaneous collection of pressure and flow data. Following the fluid dynamic model of poiseuille's law for laminar flow through a cylindrical tube, the flow of air can be quantified by dividing the pressure difference by the effective resistance. Therefore, the respiratory resistance can be found by dividing a pressure drop, which is recorded by two pressure transducers, by the flow rate, recorded by a flowmeter. My future work will be focused on testing the biofeedback capabilities of the APD in a clinical trial and gathering data on its use.

Working in the Human Performance Laboratory with Dr. Johnson has been an extremely meaningful and educational experience. Throughout my time doing research, I have had the opportunity to implement many concepts from my bioengineering coursework, such as fluid dynamics and electronics, to develop a tangible project. In the future, I aspire to attend medical school and work at the intersection between hands-on, individualized patient care and the development of biomedical therapies and technologies. I highly recommend to all students to get involved in research on campus. The technical experience and problem solving strategies have been invaluable lessons that I know I will use throughout my career. If you have any interest in research, start talking to professors - they love to talk about their research and love to hear from students that are passionate about their field even more.



DR. SOCHOL

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By Morgan Janes, Staff Editor

Just last year, the University of Maryland welcomed a new faculty member to the Department of Mechanical Engineering, Dr. Ryan D. Sochol. Fresh out of a role as an NIH Fellow within the Harvard-MIT Division of Health Sciences and Technology, he decided to come work at Maryland for the wealth of resources here that simply can't be found anywhere else. These include a wide variety of 3D printers, which is the main technological focus of his lab on campus. "My lab is the Bioinspired Advanced Manufacturing Lab, or the BAM Lab for short. The main focus of my lab is to try to use micro and nanoscale 3D printing to help solve challenges in biological or biomedical fields." So far, this has included a focus on replicating the structure of the kidney in vitro by using 3D printing to develop a microfluidic organ model containing live cells. The goal of this work is to provide a better platform for processes such as toxicity testing and disease modeling.

Though Dr. Sochol's research has a biological focus, the road to his current position involved exploration of many different fields and lots of trial and error. "I actually went to college initially thinking that I was going to be a movie director (laughs). I ended up finding a lot of similarities between engineering and science and what I liked about film." After studying mechanical engineering at Northwestern University, Dr. Sochol worked at Ford for a few years before deciding that industry wasn't the path for him. Though he wasn't involved in scientific research as an undergraduate, he found an interest in the field by exploring scientific journals, eventually deciding to attend graduate school and focus on applying mechanical engineering principles to solve biological problems. Now, he also prides himself on encouraging undergraduates to get involved in research on campus, citing mentorship as one of his greatest professional successes. "Teaching and training the next generation of engineers can be really, really rewarding." Best of all, UMD students have all the resources here to succeed. "I think the culture here is fantastic - this is definitely one of the best I've ever seen, if not the best."

Having worked in both industry and academia, Dr. Sochol cites a few differences between the two that students and recent graduates should be cognizant of as they chart their career paths. He explains that the biggest difference between the two is the eventual destination of the knowledge that is discovered. In industry, this information is often retained by the company to maintain a competitive edge and bring the best products to market. In academia, the goal is to publish new knowledge to share it with as many people as possible. However, these discoveries may not be optimized or have an eventual end user. His advice to undergraduates is to pursue as many opportunities as possible. "If you're going to make a decision that research is right for you, delve into it for a year at least. In industry, try to get an internship every summer. You're not going to know how you feel about a certain field until you try it."

In his lab, Dr. Sochol uses a team-based approach with his forty five undergraduates, who are grouped into approximately ten different teams working on separate projects. Within each group, undergraduates contribute to every step of the research process, including designing and conducting experiments, performing data analysis, writing abstracts and manuscripts, and presenting at conferences. "The type of work that they do is identical to that of graduate students, with the exception that they get to work in teams." For students looking to get involved in research on campus, Dr. Sochol emphasizes one thing in particular - enthusiasm. "If you're not genuinely excited about research, it is hard to do well." He suggests trying to speak to professors directly about their research to demonstrate interest. "If there's a way to differentiate yourself about why you are interested specifically in this particular lab, that's important. It's even better if you can talk to some other people in that lab already and they can recommend you or nominate you." Dr. Sochol is off to a great start at UMD, and we can't wait to see the great research his lab will produce in years to come!

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Perspectives

Student

Bioengineering isn't limited to academic research. Three UMD students weigh in on their industry and academic experiences in the field.

Easy Breezy Beautiful:

Memoirs of a Bioengineer's Summer in Cosmetic Manufacturing

by Janna Wisniewski, Guest Contributor

Flash back eight years. I am thirteen years old, standing in the makeup aisle of Rite Aid, deciding which dessert-scented lip gloss I would add to my already infinite collection. From an early age, I have been captivated by makeup. I remember the excitement of deciding which colors to use each day. I soon learned that sky-blue eyeshadow was not the most flattering look for me, but isn't it true that we grow the most from our biggest mistakes? This creativity and desire to be different is the same force that drove both my obsession with makeup and my choice to pursue a degree in engineering.

Flash forward. I have just finished my junior year as a Bioengineering major, and it's my first day working as a Manufacturing Engineering Intern at the CoverGirl Cosmetics plant in Hunt Valley, Maryland. My position involved overseeing the processes of the lipstick manufacturing line. There are systems of complex machinery dedicated to each step of the process: heating and distributing the formulation, securing the caps, and ensuring that all faulty sticks were removed before being packaged and shipped to stores. I soon learned to see the entire manufacturing line as a body, and began thinking of each process as a small part of the greater system, much like we are taught to do in our bioengineering classes. Like renal clearance or embryonic cell division, one mistake upstream would have dire consequences on thousands of downstream products. I was able to use the intricate problem solving techniques I learned in my coursework, and apply them to solve the problems I was given in this new context. For example, misplaced lipstick containers create errors downstream, causing minutes lost per day to reset the process. By implementing a system to remove these misplaced containers upstream, I saved the company hours of production time and thousands of dollars per year.

Perhaps an internship in cosmetic manufacturing is an unconventional choice for a bioengineer. However, conventionality has never played a big role in my life plans. I gained more from this experience than I could had ever imagined. I was given multiple vital projects to lead and complete through my 10

weeks at the plant, and I had the privilege of working closely with employees from each sector of the manufacturing business: department managers, mechanical technicians, health and safety specialists, electricians, process engineers, line leaders, and fellow interns. I learned that, even in the Google-obsessed world we inhabit, face-to-face human interaction is still our greatest resource for solving problems. I was required to learn and work quickly, to decide what needed to be done and complete it. Time really is money, especially in manufacturing; each product presents its own challenges. I wore several hats: I was part-time project manager, part-time mechanic, part-time researcher, and full-time learner. Every day was different, and every person had their own lessons to teach me.



I had an especially unique experience learning about the inner workings of big businesses. A few months before my internship began, Proctor and Gamble sold CoverGirl Cosmetics to Coty, a growing powerhouse in the beauty industry. I learned something new each day, as all employees worked effortlessly to prepare for the big transition. I realized how important it is for companies to con-

stantly think about the future and the contributions of their brands. The P&G portfolio is vast, consisting of household names such as Bounty, Olay, Secret, and Charmin. However, as you might imagine, cosmetics manufacturing is far different from the manufacturing of paper towels, soap, deodorant, and toilet paper. The markets to which the cosmetics and family care industries wish to appeal are very different. While CoverGirl was a very successful brand for P&G, all parties realized that CoverGirl no longer fit with the vision that P&G wished to portray. I know that this change will be beneficial for P&G, CoverGirl, and Coty, and will propel each company to even greater success.

Post-graduation, I hope to work in biopharmaceutical manufacturing and apply the skills I have acquired to the biomedical industry. No matter where my educational and professional paths lead, I will always have a passion for helping people. Makeup may not be medicine, but one should never underestimate the power that a tube of lipstick can have on a person's attitude. I take pride in knowing that thousands of people are smiling right now, while wearing lipstick that I helped produce.

DIFFERENT APPROACH SIMILAR GOAL

by Tim Holzberg, Guest Contributor

As a bioengineering student, I have had the opportunity to explore some of the many subfields of this major through different internship opportunities. Most of my bioengineering experiences have focused on research, and I have worked in both federal and academic environments. During the summers after my freshman and sophomore years, I worked in a protein biochemistry research laboratory at the National Institutes of Health, where I studied DNA binding specificity of various transcription factors using protein binding microarrays. I have also worked in Dr. Fisher's Tissue Engineering and Biomaterials Laboratory for over two years, and I am currently investigating how to engineer a functional cartilage trachea model using a 3D scaffold.

After completing my junior year, I branched out of research for the first time to work as a summer intern in an industry setting. I interned at the MedImmune manufacturing center in Frederick, MD. During my time there, I restructured the way that automation processes were organized for a new manufacturing facility by changing them from complicated Microsoft Excel spreadsheets into user-friendly flow charts. I learned so much about the field of biotechnology during my time at MedImmune, and I found the scientific and engineering prin-

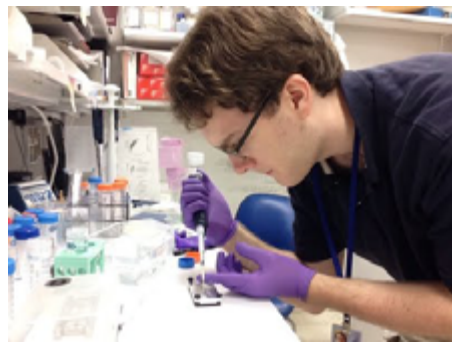
They ultimately want to find ways to improve human health and well-being just like academic institutions do, but their approach to meeting that goal is slightly different.

ciples that are applied in pharmaceutical manufacturing to be fascinating. I am eager to further explore this type of work, so I recently decided that I would like to pursue a career in the operations sector of the biopharmaceutical industry.

Each of my internship experiences was unique in many ways, but I have definitely noticed some general differences between academia and industry. The academic research experiences that I have been a part of both involved a significant amount of lab bench work and literature research. Two main goals that drive academic research in bioengineering are the pursuit for knowledge about how biological processes work, such as protein-DNA interactions that can lead to the development of cancer, and how we can solve issues using engineered constructs, like implantable artificial tracheas. Because biology is an extremely complicated field of study and there is still a lot that is unknown about it, research studies will often extend over years or even decades. However, this type of research is generally driven by both genuine curiosity and a need for new knowledge in the field that can lead to the development of a new drug delivery system, a medical device, or some other piece of technology at some point in the future.

My experience in industry showed me that the work conducted in this setting is driven by a combination of what the market needs and what the business needs. Biopharmaceutical industries need to develop safe, reliable products that will save people's lives and improve quality of life in general. However, because they are often large corporations, they need to consider how much money to invest in certain studies based on factors relating to the drug being developed and the disease being targeted, as well as how to compete with other comparable organizations. They ultimately want to find ways to improve human health and wellbeing just like academic institutions do, but their approach to meeting that goal is slightly different.

Academic and industry environments have many similarities and differences, but they definitely each have their own important role in the STEM field. Academic work expands our knowledge base and eventually leads to the development of medical technology in the future, while industry work focuses more on creating products that appeal to the company's targeted market and allow the organization to continue to expand. Although I have chosen to pursue a career in industry, many people feel that their interests lie better in the academic field because there are many areas of biology and bioengineering that should be explored further. In the end, you have to realize what type of work you're most passionate about in order to pursue a career path that you enjoy.



PACE YOURSELF

by Valerie Gupta, Guest Contributor

Through my time as a Bioengineering major at the University of Maryland, I have had the opportunity to gain research experience in both industry and academia. However, my first internship in the Biological Sciences was during my senior year of high school, at the the Mood and Anxiety Disorders Division of the National Institutes of Health. The research group that I interned with was investigating genetic indicators of Bipolar Disorder. The environment in the lab was very relaxed. The researchers also had a lot of creative right when it came to their research and were therefore able to perform the research on a flexible schedule. Although the National Institutes of Health doesn't exactly fit into the industrial side or the academic side of the bioengineering field, my experience there prompts me to liken it to academia.



My second experience in academia came when I was a freshman at the University of Maryland. During this time, I began to work at the Biomolecular and Metabolic Engineering Laboratory on campus under Dr. William Bentley. From the time I began working there through the end of my sophomore year, I worked with a graduate student in the lab and helped her with her project. During this time period, I was ex-

posed to the many different subfields of research that are currently being pursued in the bioengineering field today such as research on bacterial quorum sensing and the development of biochips for use in biological systems. My work there also helped me to become more comfortable in a laboratory setting and learn about different molecular biology protocols that are used in research today. Again, I found that the researchers in the lab had a lot of freedom to pursue different avenues of research.

During the summer after my sophomore year, I interned at MedImmune, a pharmaceutical company. This was my first experience in industry, and I really enjoyed my time there. Because industrial companies have an end goal of making profit, the people working there are under more pressure to complete their work quickly. This results in the work in industry being more fast-paced than in academia. Furthermore, work seems to be done more efficiently in industry than in academia due to a more structured workplace (most people have similar hours in the same building). Another aspect of industry that differs from academia is the implementation of strict deadlines for assignments or projects that people work on. This prevents people in industry from having as much creative freedom as people working in academia.

Today, I am drawn to pursue a career in industry as opposed to academia. Although I do appreciate the creative freedom and flexibility of schedule that is offered in academia, I like the efficiency with which work is done in industry. Furthermore, I like the idea of collaborating with a team on a project, which is a major part of work in industry.

For students who are deciding whether they want to pursue a career in industry or academia, I think that it is important to realize that neither is a bad option, as they both have advantages and disadvantages. When deciding which one to pursue, you must consider which one would better suit your personality.

Are you someone who is extremely self-motivated and greatly values your creative freedom or are you someone who appreciates a more fast-paced, team oriented work environment?

On the Cover

by Adam Berger, Staff Editor

Fluorescence makes the green light of a laser shining on pink Rhodamine 6 G dye appear more yellow in color.

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