



In this issue:

A DIAGNOSTIC
GAME CHANGER
page 2

SCUTOIDS:
UNRAVELING A
MYSTERY
page 3

BRAIN
STORMING
page 4

LARGE SCALE
MANUFACTURING
page 5

NANOSCALE
POTENTIAL
page 6

Fall 2018
Newsletter



DEPARTMENT CHAIR'S MESSAGE

Welcome to the annual newsletter of the Lehigh University Department of Bioengineering! Lots happened this last year, our first as a new department at Lehigh. We started out with a 'birthday bash' at the annual BMES meeting last year in Phoenix – we were pleased to share this exciting event with so many in the bioengineering and biomedical engineering community. It's been said that the most consequential action a faculty can take is to build by recruiting and hiring the best people. We are thrilled to welcome Dr. E. Thomas Pashuck as Assistant Professor and Dr. Ines Seabra as Visiting Professor. Dr. Pashuck develops novel polymeric biomaterials and Dr. Seabra's interests are in natural renewable plant products. We also welcome Ms. Gwynneth Hughes who joined the department in January, as graduate coordinator.

It is a pleasure, each year, to collect and write about our accomplishments over the past year. This year, the achievements are wide and deep – but there's no doubt about the highlight – surely, you've heard of the SCUTOID! Indeed, the co-discoverer of this new shape that explains how epithelial cells pack in three dimensions is our own Professor Javier Buceta. It's quite captured the imagination of the science world and beyond – check it out online and on Buceta's web page, www.thesimbiosys.com. We're very pleased that a number of our faculty members were promoted, with tenure, to Associate Professor, and in one instance to full professor. Congratulations to all.

The university is busily implementing its major growth initiative, the Path to Prominence, which will establish a College of Health and increase student enrollment by some 20%. There's much new construction on campus; one of the new buildings will be devoted to the College of Health and to new research facilities for "Health Science and Technology".

I invite you to read the rest of our news stories in the following pages of this newsletter. You'll find faculty research spotlights, stories about our undergraduate and graduate student accomplishments, and some condensed information about the department. We think you'll agree that Lehigh Bioengineers are an outstanding and dynamic group, committed to advancing human health through scientific discovery.

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Lehigh Bioengineering through the years

LAUNCHED
UNDERGRADUATE
PROGRAM

2002 ◆

GRANTED FIRST
BACHELOR'S
DEGREES

2006 ◆

LAUNCHED
GRADUATE
PROGRAM

2010 ◆

GRANTED FIRST
MASTER'S DEGREES

2011 ◆

GRANTED FIRST
DOCTORAL
DEGREES

2014 ◆

CONVERSION TO
DEPARTMENT OF
BIOENGINEERING

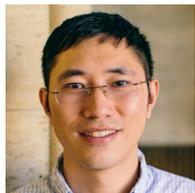
2017 ◆



A DIAGNOSTIC

GAME CHANGER

A diagnostic device developed by Yaling Liu to catch and release rare circulating tumor cells may improve diagnostic testing and therapeutic monitoring for cancer.



Yaling Liu and his team have created a diagnostic device that could be a game changer in the way cancer is monitored, and lead to personalized medical applications and more effective treatments of the deadly disease.

Liu, originally a mechanical engineer and now a professor in the Departments of Bioengineering and Mechanical Engineering & Mechanics, was struck with the original idea for the device when he chanced upon a National Institutes of Health presentation on healthcare technology in the developing world, and specifically cancer detection. According to the World Health Organization, cancer is the second-leading cause of death globally, claiming 70 percent of its victims from low- and middle-income nations. As Liu listened quietly at the back of the hall, he was struck by an idea and began scribbling some computations on a scrap of paper.

Those modest notes soon evolved into Liu's first foray into bioengineering: a polymer chip that could isolate circulating tumor cells (CTCs) from a small blood sample. The chip was cheap to produce and just a couple of square centimeters in size. Liu and his team published their results last year in the Royal Society of Chemistry's Lab on a Chip journal.

With support from the Pennsylvania Infrastructure Technology Alliance (PITA), Liu worked with Lehigh Valley Hospital to perform a clinical trial of the chip with patients undergoing cancer treatment. "Since the patients are currently battling cancer, we would expect positive results from our test, and got that on 11 of the 12 patients in the group," Liu reported. The other patient had been declared cancer free. Liu is hoping to find collaborators for the team's ongoing research, which would allow for an expansion of the promising project.

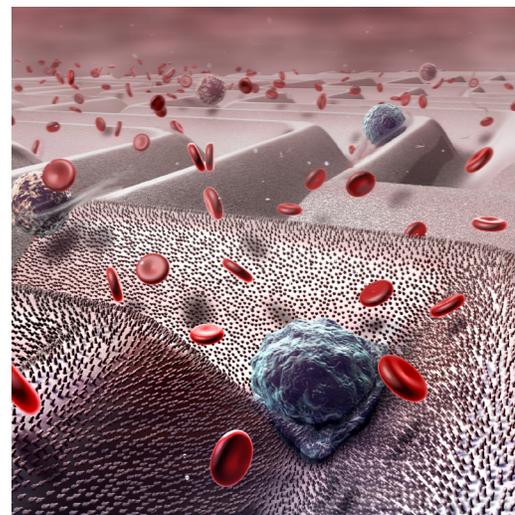
The next step for Liu is developing a more sophisticated version of the chip that can capture enough CTCs to make them available for genetic testing, which would promote the creation of customized therapies. "Chemotherapy has been the primary treatment for cancer in the past, but with the rise of immunotherapy in recent years, we need to genetically sequence the samples to focus treatment more precisely," Liu said.

Whereas earlier versions of Liu's chip employed nanoscale and microscale physical features combined with a coating of antibodies to trap CTCs, the new chip relies purely on fluid dynamics. "Tumor cells are large, and stiffer than white blood cells, so we exploit those qualities to alter their trajectory and isolate them," Liu explained. "We use patterns to amplify the movement of the cells to increase the efficiency and purity of the sample."

If the next iteration of the chip is successful, cancer patients could benefit from replacement of invasive biopsies with non-invasive monitoring of CTCs. A non-invasive genetic test of CTCs could also help clinicians detect and identify mutating cancer cells in the bloodstream, information that a biopsy of a known tumor won't provide. "The tumor cells will migrate from their original source, so if you take a biopsy of the primary tumor of the lung, if it's also gone to another organ, you will miss that," Liu said.

"BESIDES TRACKING CANCER ON THE MOVE, IF OUR TEST CAN TELL THE CANCER IS MUTATING, THAT IS PREDICTIVE OF NEW METASTASIS, WHICH IS VERY HELPFUL TO KNOW, TO SAY THE LEAST."

—Chris Quirk



Welcome NEW BIOENGINEERING FACULTY AND STAFF



Thomas Pashuck, Assistant Professor, joined the Lehigh Faculty in the Department of Bioengineering in August 2018. Pashuck develops novel biomaterials for bioengineering application.



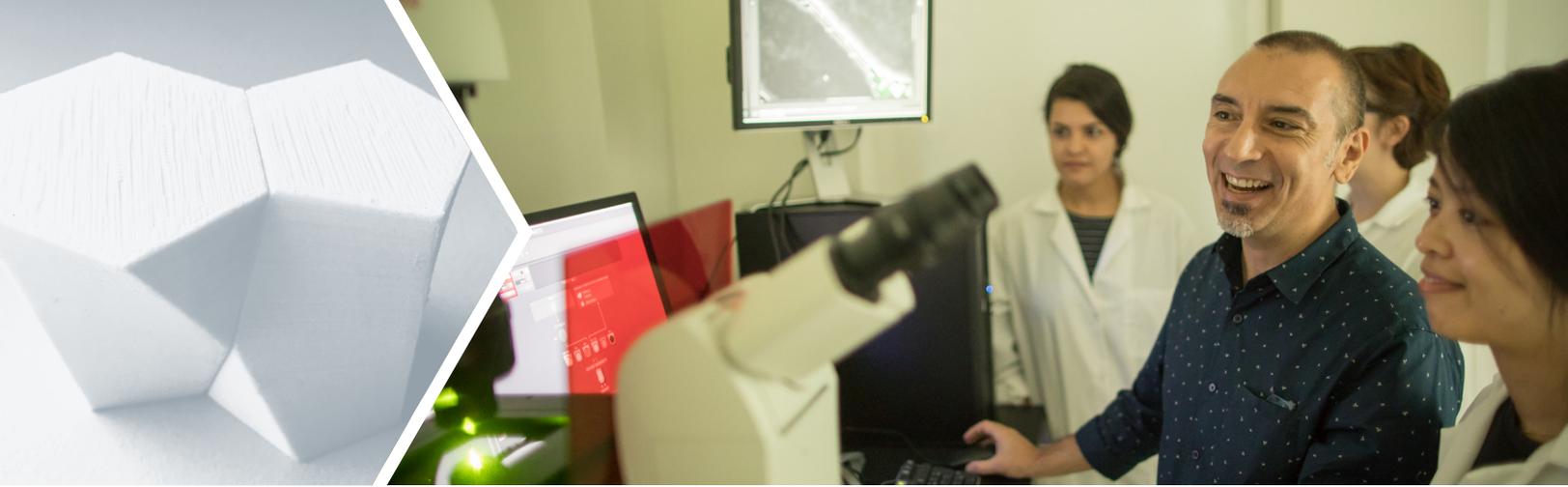
Dr. Ines Seabra obtained her PhD in Chemical Engineering from the University of Coimbra, Portugal. Prior to coming to Lehigh University, she was an associate professor at the College of Agriculture of the Polytechnic Institute of Coimbra.



Lei Zhang completed his PhD from Tsinghua University in Beijing, China and began work as a postdoctoral fellow in the Zhou research group, where he works on developing space-division multiplexing OCT and its applications.



Gwen Hughes, Graduate Coordinator, joined Bioengineering Department in January 2018.



DISCOVERY OF NEW GEOMETRIC SHAPE REVEALS A

MYSTERY OF ORGAN FORMATION



At first, Professor Javier Buceta's discovery didn't have a name. Even now, it's harder to describe it than to simply show a picture.

Scientists have long wondered what shape epithelial cells take to arrange themselves into three-dimensional tissues and organs. Javier Buceta, an associate professor in bioengineering and chemical & biomolecular engineering, has found an answer to that question. A multidisciplinary team, including mathematicians and biologists, uncovered not only the biological advantages of that shape, but in fact discovered a geometrical shape that has never been described before.

Scientists working on the problem knew that as an organism's tissues develop, their cellular building blocks form shapes that allow the whole structure to fit together perfectly, like pieces in a jigsaw puzzle. As described in the paper "Scutoids are a geometrical solution to three-dimensional packing of epithelia" in *Nature Communications* in July 2018, Buceta's team correctly theorized the complex shape that epithelial cells take when forming curved structures such as glands.

Using a computational model of a simulated tissue shaped like a toilet paper roll, the team populated the cylinder tightly with cells using Voronoi tessellation techniques, so that no gaps or spaces remained within cells. "The toilet paper roll model is the simplest geometry that has the curvature needed," Buceta said. Thus far, it was assumed that when there is some level of curvature in a tissue, the cells would pack together in a way functionally similar to blocks in a Roman arch: when rectangular blocks are packed to form an arch, the area of the cobblestones facing the outer part of the arch must be necessarily different than the area of the cobblestones facing the inner part. This shape of blocks is called, in geometry, the frustum.

One of the model's predictions was that cells used a more elaborate packing solution, following a shape that the researchers called the scutoid. It could be called a twisted prism, but that would be

oversimplification. "In biology, shape and function are correlated. What we have seen is that scutoidal cells can interchange their neighbors as you move from the outer surface of the tissue to the inner surface. That is, this shape allows cells to pack together and also to increase their level of connectivity, thus increasing their functionality by means of cell-cell communication," Buceta explained.

This shape was not evident at the beginning of the study, as no one had previously described it. "That is why mathematicians' contributions were so important," Buceta said. In a way, the initially nameless shape resembles the thorax of beetles, a structure called the scutellum. So they dubbed the new shape the scutoid.

"We predicted that every time a tissue is subjected to curvature, you will find that shape," Buceta said. Once the team theorized the shape's geometry, it moved on to examine real tissues, specifically, the cylindrical salivary glands of the *Drosophila* fly larvae. Scutoids were found, as predicted by the computer model. The team also examined other tissues and they found scutoids occurred in abundance where the tissue was curved.

As for why nature chose this elaborated geometry, the team developed a biophysical model that accounts for the packing energy. They found that scutoids allow cells to minimize that energy, thus stabilizing the three-dimensional arrangement. "So we see that nature has evolved in a way to optimize cell packing that is energy efficient," Buceta said.

Significantly, this study has implications in learning more about cell communication and how tissues form. The way cells pack is critical to development, and errors can cause a number of diseases. Buceta said **"OUR FINDINGS PAVE THE WAY TO UNDERSTANDING THE THREE-DIMENSIONAL ORGANIZATION OF EPITHELIAL ORGANS."**

—Manasee Wagh

BRAIN STORMING

By better understanding the flurries of electrical activity that occur during seizures, Yevgeny Berdichevsky may help pave the way for new treatments.



Seizures like those of epilepsy are intermittent, unpredictable, and inherently difficult to study. “You can’t just look at neural cells at any point and determine the amount of seizure activity,” says Yevgeny Berdichevsky, associate professor in Bioengineering, and Electrical and Computer Engineering. “Essentially you have to monitor

a subject or group of neurons for many hours or days.” That creates a significant bottleneck when trying to evaluate the effects of a drug or therapy.

Relieving such bottlenecks, addressing other challenges with drug-testing throughput, and learning more about neural pathways through multiple approaches is largely the focus of Berdichevsky’s research. “Our overall goal is to develop better drugs for neurological disorders and epilepsy in particular,” he says. “To do that, we need better models of the disorder.”

One key has been to develop ever more sophisticated ways to study neurons outside of the body. Neurons from the brains of animals such as rats can be kept alive in an incubator for weeks or months. When maintained under conditions similar to those of the brain, nerve cells will try to reconnect in the lab dish. “They form synapses and a neural network,” Berdichevsky says. “They also develop spontaneous neural electrical activity—and this activity resembles seizures. That’s what started my research into epilepsy.”

Learning more about how and why electrical activity occurs can help steer testing and pinpoint targets. “We’ve identified several molecules that participate in epilepsy pathways,” Berdichevsky says. But testing potential drug targets leads to the throughput bottleneck.

One challenge has been overcoming the amount of real estate that a slice from brain tissue such as a rat hippocampus takes on a drug-screening chip capable of recording electrical activity. “Monitoring just one slice that exclusively occupies the device for many days limits throughput,”

Berdichevsky says. “So why not put several slices on the same chip?” The National Institutes of Health sponsored a project to develop a multi-slice

chip. But a technical limitation hampered the idea: Each slice requires fluid to feed it, which eats up room on the chip.

To overcome the limitation, Berdichevsky and his student team developed a system of microchannels that take fluid off the chip so a slice sits in a smaller, yet continuously replaced volume. The resulting testing technology can fit six slices on a chip instead of one. The system not only speeds testing—“probably by an order of magnitude,” Berdichevsky says—but also delivers fuller data sets.

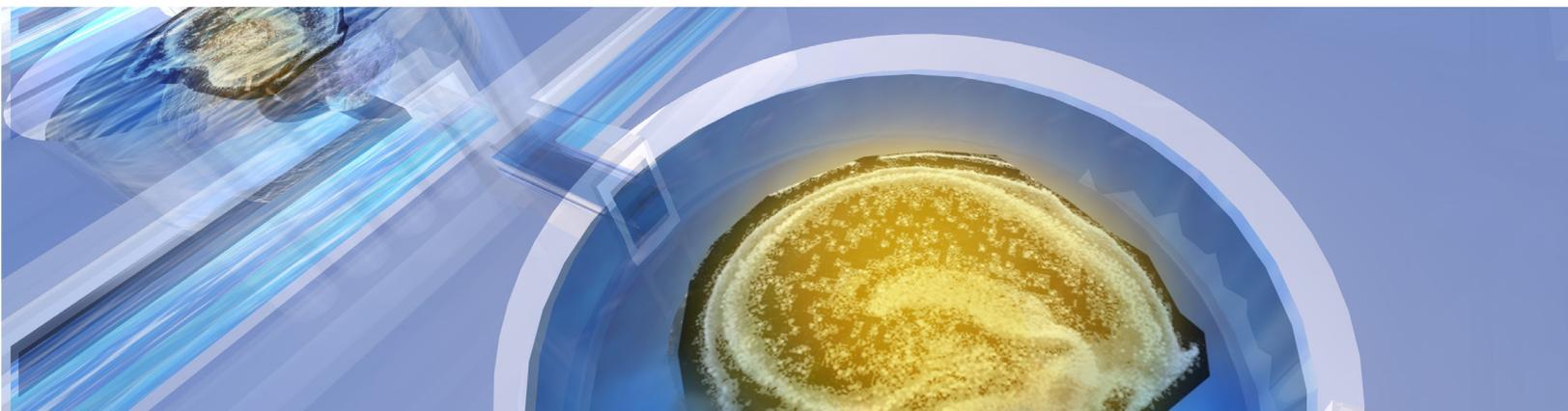
Another approach has been to better understand why spontaneous activity in slices of brain tissue has a different electrical signature than that of cultured cells that re-form connections. It’s an important question in light of technology that allows creation of human neurons from stem cells—superior to animal cells when testing human drugs. “If we could develop a model that doesn’t require brain slices, that would dramatically increase throughput,” Berdichevsky says.

In soon-to-be-published research, Berdichevsky’s team has found that using microstructures to create 3D clusters of cells rather than using more conventional 2D substrates “has a dramatic effect on spontaneous activity that is closer to what happens in the brain,” Berdichevsky says. “It’s an example of engineering function with structure.”

In other research, Berdichevsky teamed up with Xiaochen Guo and Zhiyuan Yan from Electrical and Computer Engineering Department to explore the use of living neurons for artificial intelligence tasks such as image recognition. Optogenetic interfaces would allow control of neurons by activating proteins with light.

“I THINK LEHIGH IS PARTICULARLY STRONG ON QUANTITATIVE APPROACHES TO BIOLOGICAL RESEARCH,” BERDICHEVSKY SAYS. “COMBINING THAT WITH THE LATEST TECHNOLOGY ALLOWS US TO DO QUITE INTERESTING THINGS.”

—Richard Laliberte



TRANSLATING RESEARCH DISCOVERIES TO **LARGE SCALE MANUFACTURING**



Coming from a family of teachers, Meghan Casey always had helping others as requisite for her career goal, but wasn't quite sure the direction she would take. A natural talent in math and science, Casey leaned toward medicine. "Pre-med was always on my radar for college," she said. "I hadn't considered engineering, but when I learned about the bioengineering program at Lehigh and saw the campus, I was drawn to it, and I knew it would allow me to keep my career options open."

Casey, who earned both her bachelor's and master's degrees in bioengineering at Lehigh (in 2011 and 2013 respectively), is now a process development engineer at Regeneron Pharmaceuticals, a position she began even before finishing the master's program. "There was an overlap between the two, and it was a busy time," Casey recalled. "I don't think I slept for a month."

At Regeneron, Casey works at a key juncture in the drug development process, perfecting nutrient strategies for cell lines being used to produce antibodies to treat autoimmune disorders, inflammations, macular degeneration, and other diseases. "We are downstream from R&D, at the last phase of development prior to the industrial manufacturing production. Our job is to translate research discoveries to a large-scale manufacturing process capable of producing clinical and commercial biologics," she explained. "We use genetically engineered cells to produce our drugs. This requires us to figure out how to grow and maintain the cells, and make them happy, so to speak. The work I did at Lehigh—modifying nutrient strategies to differentiate stem cells—is serving me well here."

The second half of Casey's remit is to find ways to make the drugs at volume for the marketplace. "From a business

optimization standpoint, we want to determine how to get the highest quantity from every production run, and since these biologics are going into the human body, they also have to be of the highest quality," she said. "If you compare creating a small molecule to assembling a bicycle, creating biologics is like building a jet plane."

Though inherently intrepid by nature, Casey still remembers feeling a sense of apprehension when she decided to go into engineering, a field where only one in five undergraduate students is female. "I was fortunate to have a lot of successful women role models at Lehigh, like Sabrina Jedlicka, Susan Perry and my undergraduate academic advisor, Xuanhong Cheng," she said. "In my job, I champion equal rights and empower women, and with the interns in my lab I try to instill the lessons I've learned so they can get their careers going as well."

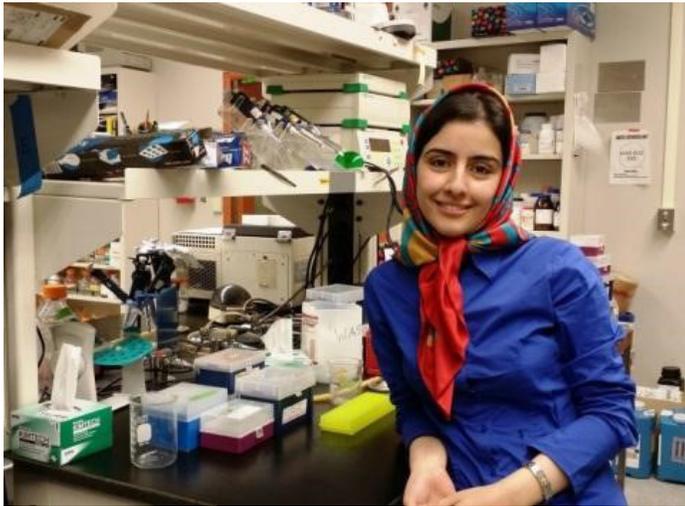
In addition to her bioengineering degrees, Casey completed a minor in political science as an undergraduate at Lehigh. "The political science helped me shape my critical thinking, and improve my communication and interactions with others. I'm not interested in running for office, but the soft skills have translated well and helped me succeed here."

Casey was recently named to a leadership team for a technology initiative at Regeneron that is in the early development stage. "There's a chance that our work will radically change our manufacturing approach," said Casey. **"IT'S EXCITING TO BE WORKING ON A PROJECT LIKE THIS, AND TO HAVE THE OPPORTUNITY TO BUILD SOMETHING FROM THE GROUND UP."**

—Chris Quirk

NANOSCALE POTENTIAL

Sajedeh Yazdanparast Tafti works to enhance knowledge of extracellular exosomes.



Imagine delving into an area of study that potentially could improve cancer diagnosis, contribute to anti-tumor vaccines, produce breakthroughs in drug delivery, and lead to novel treatments of neurologic conditions like Parkinson's disease.

Sajedeh Yazdanparast Tafti doesn't have to imagine: It's the focus of her Ph.D. thesis. "My project has to do with exosomes," Yazdanparast says—"a very hot topic with a lot of possible therapeutic applications."

Exosomes are a class of cell-derived membranous tissues known as extracellular vesicles that were largely unknown to science until the 1980s. Responsible for discarding unwanted proteins, exosomes at first were thought to be largely waste products. Most cells secrete exosomes into biological fluids like blood and urine. But cells can also take up exosomes, and an explosion of research in recent years finds they're important for cell-to-cell communication.

For example, exosomes are known to deliver messages that promote tumor growth, invasion, and metastasis, and may be involved with other disease processes as well. But they may also contribute to the therapeutic potency of mesenchymal stem cells (MSCs) by mediating micro-communication that helps develop new blood vessels, regenerate tissue, and regulate the immune system. In fact, exosomes may have therapeutic potential of their own.

What's more, exosomes' small size—between 30 and 150 nanometers—gives them a number of important advantages over MSCs. "They're less complex than cells, are more stable, and are relatively easier to produce, store, and sterilize," Yazdanparast says. Their small size allows injected exosomes to penetrate deep

into capillaries where much larger MSCs would become lodged. And being derived from cell membranes makes exosomes less likely than MSCs to be rejected by the body's immune system.

Cells share many exosomal proteins in common. But some—including certain cancer-associated proteins—are cell-specific, making it possible to use exosomes as biomarkers. "In a disease such as ovarian cancer, about 75 percent of cases aren't recognized as cancer until very late," Yazdanparast says. "By looking at exosomal microRNA, it's possible to recognize and treat ovarian cancer much sooner, potentially extending survival."

Drugs paired with exosomes have shown potential to enhance drug delivery at the nanoscale in part because exosomes are able to penetrate the blood-brain barrier that often prevents medication from reaching the brain. "Parkinson's is one disease being targeted for this kind of therapy," Yazdanparast says. "Alzheimer's disease is another."

Still, much remains unknown about exosomes, and Yazdanparast aims to help close the knowledge gap. One of her research goals is to see how exosomes may change under varying conditions such as low oxygen concentration (hypoxia) or glucose enrichment—observations powered by imaging technologies such as atomic force microscopy and dynamic light scattering. "If we can change the morphology, size, or bioactivity of exosomes, we may be able to target them differently and make them more applicable in medical therapy," Yazdanparast says.

She's also investigating the use of microcarriers—inert support matrixes on which cells can proliferate—to substantially boost production of MSC cells and related exosomes.

The interdisciplinary nature of her investigations gives Yazdanparast the opportunity to work with two faculty advisors, Sabrina Jedlicka, associate professor in the Departments of Bioengineering and Materials Science & Engineering, who specializes in cell biointerfaces, and Xiaohui (Frank) Zhang, professor in the Departments of Bioengineering and Mechanical Engineering, who specializes in mechanosensing.

"IT'S LIKE I GET TO WORK IN TWO FIELDS AT THE SAME TIME," YAZDANPARAST SAYS. "MY ADVISORS ARE NOT ONLY SUPPORTIVE AND KNOWLEDGEABLE, THEY'RE INSPIRING, AND I'M REALLY THANKFUL FOR THEM."

—Richard Laliberte

GRANT SUCCESS

JIM HSU (BIOE/ChBE) recently received funding from Dynalene, Inc. for a project titled “Cost Share for PITA XX 543728: Novel Coolants for Large-Scale Rapid Freezing of Biologics”

ANAND JAGOTA (BIOE/ChBE) and **XIAOHUI (FRANK) ZHANG** (BIOE/MEM) recently received funding from National Science Foundation for a 3-year research project titled “TIM Protein-Mediated Ebola Virus-Host Cell Adhesion: Experiments and Models”. The pair also received three years of funding from the National Institutes of Health for a research project titled, “Biomechanics of TIM Protein-Mediated Ebola Virus-Host Cell Adhesion”.

XIAOHUI (FRANK) ZHANG (BIOE/MEM) as Co-Investigator, with PI's Paul Whiteaker and Julie Miwa (BiolSci), received a grant from the National Institutes of Health for a research project titled “Prototoxin effects on nicotinic receptor function”.

WONPIL IM (BIOE/BiolSci) received funding for two projects. The first, a National Science Foundation grant, will fund research titled “Modeling and Simulation of Bacterial Outer Membranes and Interactions with Proteins.” The second, from the National Institutes for Health supports an R01 proposal titled “Development of Computational Toolset for Structural Systems Pharmacology”.

LESLEY CHOW (BIOE/MatSci) was recently awarded Lehigh's Critical Research Equipment Fund (CREF) grant to acquire an automated microwave peptide synthesizer to help accelerate and support research for at least 13 cross-college Lehigh faculty and groups at Moravian College and Rutgers University. Chow also received funding, along with collaborators Hannah Dailey (MEM) and William De Long (Orthopedic Surgery, St. Luke's University Hospital Network), from the Foundation for Orthopedic Trauma, to develop 3D printed biomaterials to treat post-traumatic osteoarthritis.

YEVGENY BERDICHEVSKY (BIOE/ECE) is a Co-PI on an NSF funded project, “Engineering Living Neural Networks for Learning,” with collaborators Xiaochen Guo (ECE) and Zhiyuan Yan (ECE). The 4-year, \$500,000 award is part of a coordinated research effort that seeks to accelerate the development of new neurotechnologies.

JAVIER BUCETA (BIOE/ChBE) and Paolo Bocchini (CEE) received a new R15 award from the National Institute of Health on “Risk Assessment of Ebola Outbreaks through Probabilistic Modeling of Chiroptera Zoonotic Dynamics and Socioeconomic Factors”, which runs through 2021.

XUANHONG CHENG (Bioengineering/MatSci & Eng) and James Hwang (ECE) were recently awarded a three-year grant by the National Science Foundation to explore a unique approach to point-of-care cancer screening and treatment monitoring.

2017 PUBLICATION SPOTLIGHT

Lehigh Bioengineering faculty members and Bioengineering students co-authored more than 55 publications that were accepted for print in the past year. Some of the notable ones are listed below. (Names in **BOLD** are current Lehigh BioE faculty or current/former Lehigh BioE students)

Yang, Y., Shankar, A., Aryaksama, T., Zheng, M. and **JAGOTA, A.** 2018. Quantification of DNA/SWCNT Solvation Differences by Aqueous Two-Phase Separation. *Langmuir* **34** (5), 1834-1843.

Moyle, N., He, Z., Wu, H., Hui, C. and **JAGOTA, A.** 2018. Indentation versus Rolling: Dependence of Adhesion on Contact Geometry for Biomimetic Structures. *Langmuir* **34** (13), 3827-3837.

Wei, W., Dong, C., Morabito, M., **CHENG, X., ZHANG, X. F.**, Webb III, E. and Oztekin, A. 2018. Coarse-Grain Modeling of Shear-Induced Binding between von Willebrand Factor and Collagen. *Biophysical Journal* **114** (8), 1816-1829.

Li, H., Multari, C., Palego, C., Ma, X., Ning, Y., **BUCETA, J.**, Hwang, J. and **CHENG, X.** 2018. Differentiation of Live and Heat-killed E. coli by Microwave Impedance Spectroscopy. *Sensors and Actuators B: Chemical* **255**, Part 2, 1614-1622.

Park, S. and **IM, W.** 2018. Quantitative Characterization of Cholesterol Partitioning between Binary Bilayers. *J. Chem. Theory Comput.* **14** (6), 2829-2833.

Min, D., Jefferson, R., Qi, Y., Wang, J., Arbing, M., **IM, W.** and Bowie, J. 2018. Unfolding of a CIC Chloride Transporter Retains Memory of its Evolutionary History. *Nature Chemical Biology* **14**, 489-496.

Wang, S., **WU, C.**, Zhang, Y., Zhong, Q., Sun, H., **CAO, W.**, Ge, G., Li, G., **ZHANG, X. F.** and Chen, J. 2018. Integrin $\alpha 4 \beta 7$ Switches its Ligand Specificity via Distinct Conformer-specific Activation. *Journal of Cell Biology*, jcb.201710022

ZHANG, X.F., Sun, D., Song, J., Zullo, J., Lipphardt, M., Coneh-Gould, L. and Goligorsky, M. 2018. Endothelial Cell Dysfunction and Glycocalyx – A Vicious Circle. *Matrix Biology*. <https://doi.org/10.1016/j.matbio.2018.01.026>

CHOW, L. 2018. Electrospinning Functionalized Polymers for Use as Tissue Engineering Scaffolds. *Biomaterials for Tissue Engineering*, 27-39.

Fiorollo, G., Bocchini, P. and **BUCETA, J.** 2018. A Predictive Spatial Distribution Framework for Filovirus-Infected Bats *Scientific Reports* **8**: 7970.

CHEN, Y., Baños, R. and **BUCETA J.** 2018. A Markovian Approach towards Bacterial Size Control and Homeostasis in Anomalous Growth Processes. *Scientific Reports* **8**: 9612.

SHI, W., Kwon, J., Huang, Y., Tan, J., **UHL, C.**, He, R., **ZHOU, C.** and **LIU, Y.** 2018. Facile Tumor Spheroids Formation in Large Quantity with Controllable Size and High Uniformity. *Scientific Reports* **8**: 6837.

Gómez-Gálvez, P., Vicente-Munuera, P., Tagua, A., Forja, C., Castro, A.M., Letrán, M., Valencia-Expósito, A., Grima, C., Bermúdez-Gallardo, M., Serrano-Pérez-Higuera, O., Cavodeassi, F., Sotillos, S., Martín-Bermudo, M.D., Márquez, A., **BUCETA, J.** and Escudero, L.M. 2018. Scutoids are a Geometrical Solution to 3D Packing of Epithelia. *Nature Communications* **9**, 2960.

UHL, C., Muzykantov, V. and **LIU, Y.** 2018. Biomimetic Microfluidic Platform for the Quantification of Transient Endothelial Monolayer Permeability and Therapeutic Transport under Mimicked Cancerous Conditions. *Biomicrofluidics* **12**, 014101.

Huang, Y., Wang, S., Guo, Q., Kessel, S., Rubinoff, I., Chan, L. L.-Y., Li, P., **LIU, Y.**, Qiu, J. and **ZHOU, C.** 2017. Optical coherence tomography detects necrotic regions and volumetrically quantifies multicellular tumor spheroids. *Cancer Research*, **77**(21), 6011-20. **News Coverage:** ScienceTrends, OCT News

Luo, X., **JEDLICKA, S.** and Jellison, K. 2017. Role of Wall Shear Stress in *Cryptosporidium parvum* Oocyst Attachment to Environmental Biofilms. *Applied Environmental Microbiology* **83**: 24e01533-17.

Zeng, X., **ZHANG, X.**, Li, C., Wang, X., Jerwick, J., Xu, T., Ning, Y., Wang, Y., Zhang, L., Zhang, Z., Ma, Y. and **ZHOU, C.** 2018. Ultrahigh-resolution optical coherence microscopy accurately classifies precancerous and cancerous human cervix free of labeling. *Theranostics*, **8**(11), 3099-3110. **News Coverage:** Theranostics Journal Cover

FACULTY

GRADUATE

NOTABLES AND MEDIA MENTIONS

YALING LIU, Professor of Bioengineering and Mechanical Engineering & Mechanics was named a fellow of the American Society of Mechanical Engineers, one of the top honors in this field. Liu has published 65 articles in peer-reviewed journals and more than 100 conference papers. He is also the author of seven book chapters and his work has led to the awarding of three U.S. patents. Liu has received funding from the National Science Foundation, the National Institutes of Health, the National Institute of Biomedical Imaging & Bioengineering, and Oak Ridge Associated Universities.

SABRINA JEDLICKA was the recipient of the 2018 Faculty Educational Innovation in Teaching Award at the Rossin College awards ceremony in May. Jedlicka, Associate Professor in the Departments of Bioengineering and Materials Science & Engineering, is the Associate Chair for Materials Science & Engineering and was recently named Director of Capstone Design for the Rossin College of Engineering & Applied Science.

Lehigh's Board of Trustees approved the promotion of **YEVGENY BERDICHEVSKY**, **XIAOHUI (FRANK) ZHANG** and **CHAO ZHOU** to Associate Professor, while **YALING LIU** was promoted to Professor. Zhang joined Lehigh's faculty in 2010 with joint appointments in Bioengineering and Mechanical Engineering & Mechanics, while Berdichevsky and Zhou, who both hold joint appointments in Bioengineering and Electrical & Computer Engineering, joined the Lehigh faculty in 2011, and 2012, respectively.

CHAO ZHOU received the Alfred Nobel Robinson Faculty Award at the 2018 Faculty & Staff Appreciation awards ceremony in May.

JAVIER BUCETA'S paper, "A Predictive Spatial Distribution Framework for Filovirus-Infected Bats" with collaborator, Paolo Bucchini, was published in Scientific Reports and was highlighted by LiveScience (<https://www.livescience.com/62647-tracking-bats-ebola-outbreaks.html>), CBC.ca (<http://www.cbc.ca/news/thenational/national-today-newsletter-russia-soccer-us-blue-wave-ebola-1.4672937>), and Medical News Today (<https://www.medicalnewstoday.com/articles/321909.php>). Buceta was also part of a multi-national research group whose computational modeling project revealed a new geometric shape, the Scutoid, used by nature to efficiently pack cells. The report, published in Nature Communications was covered by Phys Org (<https://phys.org/news/2018-07-reveals-geometric-nature-cells-efficiently.html>) and The New Yorker (<https://www.newyorker.com/elements/lab-notes/we-are-all-scutoids-a-brand-new-shape-explained>)

NEWS

Congratulations to our 2018 Bioengineering graduate degree recipients: **WENTAO SHI, PHD '18** (Liu lab), **CHRISTOPHER UHL, PHD '18** (Liu lab), **JAMES GRABER, MS '18**, **HAO HUANG, MS '18**, **MEGAN KOZAR, MS '18**, **WHITNEY LAI, MS '18** (Zhang lab) and **MICHELLE MAZZEO, MS '18** (Schultz lab).

WENPENG CAO, **YANYAN CHEN** and **JING MEN** were named Rossin Doctoral Fellows for the 2018-19 academic year. All three students in the Bioengineering doctoral program will take part in the special preparation for careers in academia and research provided by a gift from the late Peter C. Rossin '48.

MICHELLE MAZZEO, BS (ChBE) '17, MS (BioE) '18 (Schultz lab), placed 2nd in the poster competition of the 89th Annual Meeting of the Society for Rheology. Michelle began her research while she was an undergraduate student at Lehigh and continued her research as a Presidential Scholar. Michelle's poster was entitled, "Determination of macroscopic rheological properties of human mesenchymal stem cell laden poly(ethylene glycol) hydrogels" by Michelle S. Mazzeo and Kelly M. Schultz.

ALUMNI UPDATE

WENTAO SHI, PHD '18 (Liu Lab) has taken a position at Aptitude Medical Systems, Inc, a Santa Barbara, CA based company focused on the development of aptamer-based diagnostic products.

RYAN MCKAY, BS '12, MS '13 recently received his PhD from the Department of Bioengineering & Biomedical Engineering at the University of Maryland and has taken a position as Associate Scientist at Regeneron Pharmaceuticals, joining a growing group of Lehigh alumni at the leading biotechnology company.

TRACY (GWYTHYR) HOOKWAY, BS '06, who obtained her PhD from Worcester Polytechnic University and completed postdoctoral fellowships at Georgia Institute of Technology and the Gladstone Institute of Cardiovascular Disease, is an Assistant Professor in the Department of Biomedical Engineering at Binghamton University, State University of New York. Hookway's work focuses on developing engineered in vitro models of human cardiovascular disease.

UNDERGRADUATE

STUDENT SUCCESS

Our undergraduate Bioengineering majors had another awesome year of contribution to the campus and local communities, and the impact of their academic and service work continues to be felt at home and abroad.

LIAM DOW '18 (Zhang lab), **EVAN ECKERSLEY (IBE/BIOE '17)**, **DIVYA PATEL '18** (Chow lab), **PRIYOKTI RANA '18** (Cheng lab), **LARA REID '19** (Liu lab), **MADISON SCHENKER '18** (Berdichevsky lab), **KELLY SEIMS '18** (Chow lab) and **ANXHELA SINANI '19** (Brown lab) traveled to Phoenix in October 2017 for the Biomedical Engineering Society Meeting. All presented their independent research work in the undergraduate research poster session, and all students in attendance took advantage of the opportunity to network with graduate program and corporate representatives.

ERIN AKINS BIOE '17 was awarded a prestigious 2018 National Science Foundation Graduate Fellowship. Erin recently entered the Berkeley/UCSF joint graduate program in Bioengineering.

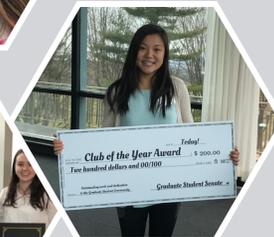
For the third year in a row, a Lehigh Bioengineering student received an award at the 2018 David and Lorraine Freed Undergraduate Research Symposium. **DIVYA PATEL** (BIOE, '18) was awarded the People's Choice award for her research titled "3D Printing with Peptide-Polymer Conjugates to Regenerate the Osteochondral Interface" under the supervision of Prof. Lesley Chow. Bioengineering students **REILLY CALLAHAN** (Honorable Mention), **KELLY SEIMS** and **ANXHELA SINANI** also participated in the symposium.

ANNIE BEHRE joined a prestigious group of women undergraduates of the P.C. Rossin College of Engineering by being named a Clare Boothe Luce Research Scholar. Annie joined the lab of Prof. Lesley Chow, in spring 2018. Two additional students in the Chow lab, **IVAN SPANN '20** and **SYDNEY YANG '19**, were awarded Grants for Experiential Learning in Health (GELH) for summer 2018.

The student organization, "Enabling the Future," founded by bioengineering students **WHITNEY LAI '15**, **'18G** and **BONAIRE BERRY '18**, won an award for the "2018 Student Club of the Year." Enabling the Future is an open source organization that establishes chapters across the country. Each chapter has the ability to take on recipients and modify designs created by the group and 3D print affordable upper limb assist devices. The chapter delivered a 3D printed finger to their first recipient in spring 2018.

Students **PHOEBE WAGER '18** and Amanda Ritter '18, (CEE) completed an 11-week cross country bike trip to raise awareness for affordable housing through the non-profit organization Bike & Build, which helps to educate the public and build affordable homes for families in need.

Bioengineering student, **MICHAEL WU '20** is a member of a team of Lehigh undergraduates that was one of five finalists in the \$1 million Anu and Naveen Jain Women's Safety Prize competition. In the competition announcement at the United Nations in June, Team Soterra was awarded \$50,000 for further development of their women's safety device, Soterra, a device that can autonomously and inconspicuously trigger an emergency alert, while transmitting information to a network of community responders, all within 90 seconds.



BIOENGINEERING RESEARCH AT LEHIGH UNIVERSITY

Names in **BOLD** are Lehigh BioE core faculty.

BIOCOMPUTATIONS AND MODELING

Biomolecular Modeling
Bioinformatics
Bioengineering Systems & Controls
Biophysics

Modeling of Biological Systems
Computational Bioengineering
Data Analytics
Biomedical Image Analysis

Y. BERDICHEVSKY, **J. BUCETA**, B. Chen, **J. HSU**, **W. IM**, **A. JAGOTA**, M. Kotare, **Y. LIU**,
D. Lopresti, J. Mittal, **D. OU-YANG**, D. Vavylonis, A. Voloshin

DIAGNOSTICS, SENSORS AND DEVICES

Biomedical Imaging
Biophotonics
BioMEMS
Biosensors

Microfluidics
Bioelectronics
Medical Devices

Y. BERDICHEVSKY, D. Brown, **J. BUCETA**, **X. CHENG**, H. Dailey, J. Hwang, **Y. LIU**,
D. Lopresti, **L. LOWE-KRENTZ**, **D. OU-YANG**, **S. TATIC-LUCIC**, D. Vavylonis, D. Vezenov, **C. ZHOU**

MATERIALS AND THERAPIES

Biomaterials
Molecular Bioengineering
Biopharmaceutical Engineering
Cell & Tissue Engineering

Neuroengineering
Biofluid & Solid Mechanics
Biomolecular & Cellular Mechanics
Environmental Bioengineering

Y. BERDICHEVSKY, A. Brown, D. Brown, **J. BUCETA**, **X. CHENG**, **L. CHOW**, H. Dailey, M. Falk, **J. HSU**, **W. IM**, **A. JAGOTA**,
S. JEDLICKA, H. Jain, **Y. LIU**, **D. OU-YANG**, **T. PASHUCK**, K. Shultz, **S. TATIC-LUCIC**, D. Thevenin, D. Vezenov, A. Voloshin, **F. ZHANG**

Additional Bioengineering related research can be found in Industrial Systems Engineering (<https://ise.lehigh.edu>) and Healthcare Systems Engineering (<http://hse.lehigh.edu>).



Faculty members missing from the picture: Yevgeny Berdichevsky, Wonpil Im, Sabrina Jedlicka, Daniel Ou-Yang and Chao Zhou.

*Department
at a glance:*



16
CORE FACULTY
MEMBERS



14
ASSOCIATED FACULTY
MEMBERS

7
POST-DOCTORAL
SCIENTISTS

1
TECHNICAL &
2 ADMINISTRATIVE
STAFF



14
PHD LEVEL
GRADUATE
STUDENTS

6
MS LEVEL
GRADUATE
STUDENTS



219
UNDERGRADUATE
MAJORS IN 3
UNDERGRADUATE
TRACKS

*(Biopharmaceutical Engineering,
Bioelectronics & Biophotonics, and
Biomechanics & Biomaterials)*

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of Engineering and
Applied Science