“It’s like lightning and thunder.”

That’s how assistant professor of biomedical engineering Srivalleesha Mallidi describes the photoacoustic imaging technology that she uses for cancer research in her Integrated Biofunctional Imaging and Therapeutics Laboratory at Tufts—also known as the iBITLab.

The lab focuses on using light and sound energy to image tumors non-invasively in their early stages. Mallidi’s research utilizes a photoacoustic phenomenon where a short pulse nanosecond laser light generates sound waves around the tumor for detection by ultrasound. Different light wavelengths show the region’s vascular density and oxygenation to better understand the tumor’s properties. When patients are injected with a contrast agent that can

Guiding surgical methods, predicting therapeutic response, and designing effective therapeutic strategies are the core of Mallidi’s work in the iBITLab.

Continued on page 3
plays a key role in assuring that each
generation of students graduates with
a strong commitment to becoming
leaders in advancing scientific and
engineering principles while also
functioning as knowledgeable and
compassionate citizens within both
global and local communities. I am so
proud of each and every one of you, our
students, as you leave the Tufts campus
and head out into the world carrying
forward your personal experiences
and intellectual strengths to whatever
career path you follow. Hopefully you
feel that we have achieved our mission
of teaching and mentoring you in your
chosen field even while navigating the
daily emergencies, cyclical political
climate, and uncertain economic times
we have experienced of late.

This message would not be complete
unless it recognizes the extreme change
and stressors our globe is going through
at this time as a pandemic assaults
our humanity and is making everyone
question their future place in the world.
We, as a faculty, recognize the fears
and concerns you all must have right
now. Let me say that in my mind, the
message stays the same: regardless
of whether you work in rebuilding the
scientific, medical, or engineering needs
to come in the future, your education
in Biomedical Engineering will have a
central role in all aspects of the work
ahead of us as a society. To our current
students and alums: be strong, be safe,
keep up the great work you have started,
and continue to make us proud.

David Kaplan
Professor and Chair
Stern Family Professor of Engineering

Friends and Colleagues,
Within the city of Boston, we live in
an enriched ecosystem of science,
engineering, and medicine; arguably an
er epicenter for much of the most current
knowledge in the world on these topics.
As an academic institution, Tufts

FROM THE CHAIR

QUICK HITS

Professor Irene Georgakoudi was
elected a Fellow of SPIE, the International Society
for Optics and Photonics.

Assistant Professor Xiaocheng Jiang was appointed to the John A.
and Dorothy M. Adams Faculty Development
Assistant Professorship.

Professor David Kaplan
was listed as one of the top
translational researchers
in biotech, according to
Nature Biotechnology.

Assistant Professor Srivalleesha Mallidi
received a 2019 Early Investigator Award
from the International Photodynamic Association.

Assistant Professor Madeleine Oudin was
named to BMES-CMBE's 2020 Class of Rising Stars,
recognizing her as an exceptional junior principal investigator.

Associate Professors Lauren Black and Qiaobing Xu
were elected to the American Institute for Medical and Biological Engineering College
of Fellows.

Professor Fiorenzo Omenetto was elected
a Fellow of the National Academy of Inventors.

Professor Tom Baran and Matt Hirch, both
E04, launched Lumii, a company that uses
complex algorithms to place dots of ink to
add depth, motion, and chromatic effects to
packages and labels.

Assistant Professor Madeleine Oudin
received an early career investigator award from the METAivor Metastatic Breast
Cancer Foundation.

PhD candidate Natalie Rubio's research
on sustainable meat was featured in
media ranging from WBZ's Boston Next
series to The Conversation.

A Tufts BME alum was named a fellow
in the 2020 National Science Foundation
Graduate Research Fellowship Program.

Megan Tse, E18, is now pursuing a
PhD at Brown University, where her
research interests include biomaterials,
microneedles, drug delivery, and tissue
engineering.

Notables...
specifically localize the tumors, the use of photoacoustics can then also identify the margins of the tumor, helping surgeons save as much healthy tissue as possible. Mallidi is collaborating with Massachusetts General Hospital to test this research on oral cancer patient samples and has so far observed positive results in preclinical models. The use of an ultrasound machine versus an MRI or CT scanner is also a cost-effective boon and more widely available to patients.

The iBITLab is also working on developing algorithms to predict treatment response at early time points, particularly looking at vascular and hypoxia surrogate markers. “The main way tumors get nutrients is through these blood vessels. However, due to excessive growth, tumors also have hypoxic areas,” Mallidi explains. Chemotherapy and radiation don’t work in a hypoxic environment, so she is researching how to predict, with imaging biomarkers, whether a patient will respond to these therapies or not—saving valuable time, understanding resistance to therapy, and reducing overexposure to systemically toxic therapies.

Guiding surgical methods, predicting therapeutic response, and designing effective therapeutic strategies are the core of Mallidi’s work in the iBITLab. But the crown jewel has become her recent work on image-guided photodynamic therapy, or PDT, a light-based therapy in which wavelengths of light irradiate, and kill, cancer cells loaded with a light-activated cytotoxic drug called a photosensitizer.

“PDT has been around for a long time, at least 20 years,” Mallidi says, “but hasn’t caught up to mainstream therapy, despite showing great promise.” When PDT was introduced, patients had significant photo-toxicity: for example, when a photosensitizer was injected, any sun exposure was toxic. But today, tumor localization is possible via encapsulation in nanoparticles. Combined with photoacoustic imaging to understand drug delivery, designing dosimetry and monitoring treatment response, better treatment strategies are on the horizon.

At the 2019 International Photodynamic Association World Congress, Mallidi was honored with the Early Investigator Award in recognition of her exceptional research and clinical translation of PDT.

“It really excites me,” she says. “I’m an electronics engineer by training and my PhD focused on building imaging systems.” Before beginning her post-doctoral work at Harvard, she had limited knowledge of cancer research and nanotechnology. But, like everyone, Mallidi’s family was also affected by cancer. “I wondered, ‘Can we do something about this?’”

“Now that I’m at Tufts, where I’m able to integrate all of my research, I’m motivated every day to get up, deeply think about the problem, and find new solutions.”

—Kristin Livingston, A05

Going to Great Wavelengths Continued from page 1

LabORatory for LivInG devIceS

Launched this year, the Laboratory for Living Devices (L²D) is a new initiative at Tufts built on the understanding that “the potential for effective, affordable, and sustainable devices with novel capabilities requires an integrated approach with strong scientific leadership and thoughtful design practices.”

Fiorenzo Omenetto, Frank C. Doble Professor of Engineering, collaborated with three other founding faculty members to found the laboratory: Assistant Professor Bree Aldridge of the School of Medicine (and adjunct assistant professor in Biomedical Engineering), Assistant Professor Charlie Mace of the Department of Chemistry, and José Ordovás, director of the Nutrition and Genomics Laboratory at the Jean Mayer USDA Human Nutrition Research Center on Aging at Tufts.

The Laboratory for Living Devices hosted L²D Day in November 2019 to introduce the Tufts community to researchers’ work and to launch conversations with students and faculty that could jumpstart new collaborative research. When technology and biology come together, “we can make materials do unexpected things,” Omenetto told Tufts Now. “All of us who work in the lab are people who like to live in the middle of that world of possibilities—and we are eager to share our expertise with each other. That exchange automatically informs directions, problems, solutions. It empowers creativity.” Learn more at livingdevices.tufts.edu.
Shining a Light on Optical Imaging

In the Diffuse Optical Imaging of Tissue (DOIT) Lab at Tufts University, Professor Sergio Fantini and collaborators—including Research Assistant Professor Angelo Sassaroli and PhD candidates Giles Blaney, Thao Pham, and Cristianne Fernandez—study biological tissue at a macroscopic scale. In the DOIT Lab, Fantini and colleagues recently published three papers on a new approach to near-infrared spectroscopy (NIRS) that offers better sensitivity and more targeted study of deeper biological tissue.

Currently, researchers strive to measure and quantify confounding effects from superficial tissue. That work has been done with variable success, so Fantini and the DOIT Lab proposed a novel approach: suppressing the sensitivity of optical signals to these confounds. They developed a new arrangement with a dual-slope approach that calls for at least two sources and two detectors laid out in specially-configured arrays. Their proposed approach would allow researchers to study localized points deeper in tissue. The Tufts researchers’ results, in studying the new dual-slope approach, demonstrated major advances over more traditional single-distance or single-slope data, allowing for greater depth sensitivity in NIRS imaging.

Label-Free Laser Microscopy

A multiphoton laser microscopy technique, developed by researchers including Professor Irene Georgakoudi, PhD alumna Dimitra Pouli, and Dr. Thomas Schnelldorfer of Lahey Hospital, is able to identify very small metastatic areas in women undergoing treatment for ovarian cancer.

The technique, reported in Biomedical Optics Express, combines advanced microscopy with computational analysis and can non-invasively detect micro-metastases that develop from parent tumors. The team studied biopsies from eight patients with promising results—40 of the 41 images were classified correctly, with all 11 metastatic samples identified correctly.

3D Tissue Models of Brain Tumors

A team of Tufts-led researchers developed three-dimensional (3D) human tissue culture models of pediatric and adult brain cancers in a brain-mimicking microenvironment, a significant advancement for the study of brain tumor biology and pharmacological response. The study was published in Nature Communications and co-authors from the Department of Biomedical Engineering included Professors David Kaplan and Irene Georgakoudi, Associate Professor Lauren Black, and PhD students Disha Sood, Dimitra Pouli, Craig Mizzoni, and Nicole Raia.

The researchers created models that include brain-derived extracellular matrix (ECM)—the complex network of proteins and amino acids with bound sugars naturally found in the brain. The ECM not only provides support for surrounding neural tissue, but also helps to guide cell growth and development. Alterations in ECM composition have been associated with brain tumor progression, which in turn alters patterns of genetic and protein expression in the tumor cells.

Cultured Meat

A team of researchers exploring the development of cultured meat found that the addition of the iron-carrying protein myoglobin improves the growth, texture and color of bovine muscle grown from cells in culture. This development is a step toward the ultimate goal of growing meat from livestock animal cells for human consumption.

The researchers—including Professor David Kaplan, research fellow Robin Simsa, PhD candidates John Yuen, Andrew Stout, and Natalie Rubio, and Per Fogelstrand of the University of Gothenburg—found that myoglobin increased the proliferation and metabolic activity of bovine muscle satellite cells. Addition of either myoglobin or hemoglobin also led to a change of color more comparable to beef. The results, published in FOODS, indicate potential benefits of adding heme proteins to cell media to improve the color and texture of cell-grown meat.
**Nanoparticle Gene Editing**

In a research collaboration between Tufts University and the Chinese Academy of Sciences, Associate Professor Qiaobing Xu and colleagues developed a significantly improved delivery mechanism for the CRISPR/Cas9 gene editing method in the liver. They used lipid nanoparticles to deliver CRISPR/Cas9 gene editing tools for potential treatment of hyperlipidemia.

The nanoparticles represent one of the most efficient CRISPR/Cas9 delivery tools reported so far.

The lipid nanoparticles described in the study, published in *Advanced Materials*, encapsulate messenger RNA (mRNA) encoding Cas9. Once the contents of the nanoparticles—including the sgRNA—are released into the cell, the cell’s protein-making machinery takes over and creates Cas9 from the mRNA template, completing the gene editing kit.

**Wrinkling Silk**

Silk Lab researchers—including postdoctoral fellows Yu Wang and Berney Peng, Professor Fiorenzo Omenetto, and graduate students Wenyi Li, Yuqi Wang, and Meng Li—developed silk materials that can wrinkle into highly detailed patterns, including words, textures, and images as intricate as a QR code or a fingerprint. The patterns take about one second to form and are stable but can be erased by flooding the surface of the silk with vapor. In an article published in the *Proceedings of the National Academy of Sciences*, the researchers demonstrated examples of the silk wrinkle patterns.

The list of potential applications includes materials with tunable optical properties, some of which may involve the use of dopants that allow the patterned fabric to absorb or emit different wavelengths of light and energy, or exhibit patterns only from specific angles; and materials that modulate their thermal properties, changing the amount of heat they let through. Due to the biocompatibility of the silk fibers, the micropatterning material could be used in various biomedical applications.

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**BMES 2019**

Janani Baskaran, E20, and fellow students presented research at BMES.

This year, the Tufts BME chapter continued to focus on developing new events and opportunities for students to network and socialize. If you’re interested in learning more or would like to get involved with BMES, email bmestufts@gmail.com or visit sites.tufts.edu/BMES.

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**NEW FACES**

**Jonathan Zhang**

Professor of the Practice Jonathan Z. Zhang is a dedicated and experienced leader and serial inventor who enables people and resources for technology innovation and product development. He specializes in implantable medical devices with a strong background in new product/process development, polymer chemistry, biomaterials, analytical chemistry, biocompatibility, and preclinical models. He has more than 15 years of experience leading product development and POC research in regulated environments.

**Sonke Svenson**

Professor of the Practice Sonke Svenson’s professional achievements include the development of scalable particle engineering techniques to improve the solubility of drugs and the development of a novel dendrimer platform with improved performance and cost profile. In 2017, he became the managing director for NanoCarrier Co., Ltd, Japan, building business relations to pharma and biotech companies in the US and EU. His current focus is on providing expertise in drug delivery and formulation challenges for small molecule drugs as well as biomolecules as the founder of Drug Delivery Solutions LLC.
CONGRATULATIONS TO OUR 2019 GRADUATES

Bachelor of Science in Biomedical Engineering

Nadia Abdullah   Lily McCarthy
Siddhant Agarwal   Caroline McCormick
Emile Ansari   Anastasia McLisky
Janani Baskaran   Gonzalo Miranda
Ryan Bell   Mohamed Nassar
Jeremee Bornstein   Thomas Nyalile
Jayanth Dabbi   Faith Ocitti
Anne Geheran   Emily Peirent
Michael Glass   Michael Pine
William Glockner   Javier Rincon
Laurel Howell   Sameer Sarma
Sara Kalra   Bradley Schus sel
Joseph Krawitz   Isabel Smokelin
Andre LaPan   Joseph Tramontozzi
Maya Laughton   Trent Turner
Daniel Levitin   Sakshi Wadhwa
Carlos Lopez   Nelson Zhang
Rodriguez

Master of Science in Biomedical Engineering

Ruth Castillo Lagos   Zachary Kops
Brendon Clove r   Xincheng Li
Fabio De Ferrari   Caitlin Van Wicklin
Jingzhu Hao   Ce Yang
Kevin Kapner   Qing Zhu

Master of Science in Bioengineering (Biomaterials track)

Kelsey-Claire Gallagher   Manisha Raghavan
Qi Hu   Jialin Zhang

Certificate in Biomedical Engineering

Mateo Dallos

Doctoral Recipients

Sarah Bradner
Systematic silk hydrogel microfiber design: platform for meticulous fibrous material scaffold
Advisor: David Kaplan

Wenyi Li
Fabrication of functional surface patterns by inkjet printing
Advisor: Fiorenzo Omenetto

Eleana Manousiouthakis
Bioengineered in vitro 3D human enteric nervous system
Advisor: David Kaplan

Meghan McGill
Characterization and chemical modifications of silk fibroin hydrogels towards advanced biomaterial scaffold
Advisor: David Kaplan

Nicole Raia
Silk hyaluronic acid composite hydrogel for soft tissue engineering
Advisor: David Kaplan

Maria Rodriguez
Advances in medical device manufacturing using biomaterials
Advisor: David Kaplan

Disha Sood
Physiological 3D bioengineered brain cultures enriched with bio-inspired matrix for disease modeling and therapeutic discovery
Advisor: David Kaplan

Sarah Vidal Yucha
Development of a complex, full thickness, in vitro human skin tissue with neuronal and immune components
Advisor: David Kaplan

Keep in Touch

1. E-mail BME_Alumni@tufts.edu with your news, stories, and updated contact information. If you’re not receiving e-mails from us, please let us know!
2. Join our graduate and undergraduate LinkedIn groups.
3. Visit the Tufts Online Community: tuftsalumni.org/olc.
4. Our Alumni Group is looking for volunteers to help plan and host networking events and activities, and to mentor current students. For more information, contact Associate Professor Lauren Black at lauren.black@tufts.edu.

Photos, left to right: Meghan McGill celebrates earning her PhD with Professor and Chair David Kaplan; Newly-minted PhD Maria Rodriguez is all smiles.

Look for recognition of 2020 graduates in next year’s newsletter!
The Biomedical Engineering and Chemical Engineering Society (BEaChES) had an active year, hosting social opportunities for graduate students like the annual BEaChES Halloween party and winter study break. In December, volunteers from BEaChES visited Medford High School and taught students the science of synthesizing biofuels from cooking oil. The volunteers demonstrated how to properly use personal protective equipment for safety while showing off science in a fun and engaging way. After the demonstration, the Medford students were able to create their own biofuels with the instructions provided.

Research Scholars—TUBERS

This past summer was the eighth year of the Tufts University Biomedical Engineering Research Scholars Program (TUBERS), where local high school students work in the Tufts labs over the summer. This past summer, 27 rising juniors or seniors at local high schools were invited to the Science and Technology Center for six weeks to gain hands-on laboratory experience. Postdocs and graduate students presented modules related to several of the faculty labs with hands-on lab work and students were able to spend the last two weeks working on a project with a mentor. The summer culminated in a poster presentation session where TUBERS students were able to present their summer work. If you have any questions or suggestions for the program, please contact Associate Professor Lauren Black at lauren.black@tufts.edu.

Seminar Speakers

This academic year, the department invited a number of impressive guest speakers to campus to talk with BME students in weekly seminars. While some spring semester speakers were not able to join us due to the cancellation of on-campus events, the department appreciates all speakers’ willingness to share their research and experiences with students. Scheduled guests included:

**Fall 2019**
- Katie Whitehead, Carnegie Mellon University
- Kristin Naegle, University of Virginia
- Ingrid van Welie, Neural Dynamics Technologies
- Christine Hendon, Columbia Engineering
- Matthew Paszek, Cornell University
- Stephanie Fraley, UC San Diego
- Molly Shoichet, University of Toronto
- Daniel Lever, Emulate Bio
- Allison Dennis, Boston University
- Anita Shukla, Brown University
- Zeinab Hajjarian, Massachusetts General Hospital

**Spring 2020**
- Chulhong Kim, POSTECH, Korea and Stanford University
- Debra Auguste, Northeastern University
- Darren Roblyer, Boston University
- Ying Li, University of Connecticut
- Erin Purcell, Michigan State University
- Tyrone Porter, Boston University
- Claudia Fischach-Teschl, Cornell University
- Samir Mitragotri, Harvard University
- Aaron Meyer, University of California, Los Angeles
- Amy Brock, University of Texas at Austin
- Jennifer Lippincott-Schwartz, Janelia Research Campus
Akshita Rao, E21, spent her summer studying the effects of acute hypoxia in cardiac cells, working as a team with Assistant Professor Brian Timko and doctoral candidate Olurotimi “Rotimi” Bolonduro. Learn more about Rao’s Summer Scholars project at go.tufts.edu/rao, and about the team’s publication in Nano Letters at go.tufts.edu/ischemia.