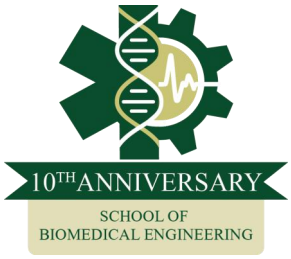
Volume 5, Issue 2 Fall 2017

SCHOOL OF BIOMEDICAL ENGINEERING
COLORADO STATE UNIVERSITY

Message from Director

Milestone year for the CSU School of Biomedical Engineering



The School of Biomedical Engineering (SBME) at Colorado State University is proud to celebrate its **10th anniversary** as a graduate degree-granting program. Tenth anniversaries are often celebrated as evidence of flexibility and durability with tin or aluminum; in BME this might be nitinol or polydimethylsiloxane. SBME was built on a foundation of excellence in four colleges, including the Colleges of Engineering, Health and Human Sciences, Natural Sciences, and Veterinary Medicine and Biomedical Sciences. We celebrate our interdisciplinary commitment to improve health, fight disease, and aid persons with disabilities. Our flexibility is highlighted by continued expansion to new research horizons over the last ten years. The faculty has grown from 29 core faculty in 2007 to almost 50 core faculty today, with more planned. Our durability is revealed in the vibrant growth of student enrollment and by progression to the top half of biomedical engineering programs in the country based on *U.S. News & World Report*.

One interesting anniversary relatable to biomedical engineering is the origin of the novel *Frankenstein*, a story of technology jumping ethical (and technical) boundaries. Mary Shelley started writing her *Frankenstein* in the summer of 1817. According to the introduction of the 1831 edition, discussions in the Shelley household included principles of life and the idea that a corpse could be re-animated based on work of Luigi Galvani (1791). It was an "electric debate" between Galvani and Alessandro Volta that some believe led to today's electrophysiology. It is not hard to argue that technology in biomedical engineering can be traced to these early thoughts that can be seen in the repair or replacement of organs with stem cells, or the sensors and stimulators of numerous bodily functions. Appealing to a wide audience, Shelley's literary work and the concepts inherent within continue to ignite tough ethical and scientific questions about biomedical technologies today.

The Biomedical Engineering Society (BMES), a professional society devoted to promoting biomedical engineering world-wide, will also celebrate its 50th anniversary in 2018. In this magical year of 2017-18 perhaps new "firsts" will be established for celebrations in future years!

I welcome your participation, insights, questions, and ideas surrounding this milestone year. You can reach me at 970-491-7157 or Stuart.Tobet@colostate.edu.

Sincerely,

Stuart Tobet, Director

Built on strong faculty & research programs

Walter Scott Jr. College of Engineering

College of Health and Human Sciences

College of Natural Sciences

College of Veterinary Medicine & Biomedical Sciences

In this issue

Congratulations to the Class of 2017!

Bachelor of Science in Biomedical Engineering and Chemical and Biological Engineering

Michelle Ablutz
Michael Anzueto McGarry
Kenzie Baer
Ben Bagby
Terrance Bishop
Mitch Durham
Stephen Hughes
Scott Jamison
Michael May
Will Raymond
Bo Reilly
Micki Repasky

Bachelor of Science in Biomedical Engineering and Mechanical Engineering

Lauren Blume
Michael Collins
Lindy Gillette
Michael Hattel
Joe Johnson
Chase Kohlberg
Morgan Leatherland
Natalie Lusk
Jesse Masterson
Hannah McIntyre
Ben Melia
Lucas Nakamura
Mollie Phillips
Noellyn Pineda
Jared Struck
Krystal Tamayo
Sean Visocky
Donald White
Bryce Wilson
Jake Wolynski
Allie Zirger

Bachelor of Science in Biomedical Engineering and Electrical Engineering

Maddi Repasky
Alexander Rich
Robby Stokoe

Bachelor of Science in Biomedical Engineering and Electrical Engineering with a concentration in Lasers & Optics

Nick Brown
Matthew Carter

Master of Science, Bioengineering

Molly Hischke
Kanti Nepal

Doctor of Philosophy, Bioengineering

Samanthe Lyons

The company we keep

Each semester, the School of Biomedical Engineering invites distinguished guests from around the world to speak on biomedical engineering research and related disciplines for its weekly seminar series. The Spring 2017 speakers included:

DR. MARIANO BUFFONE
National Scientific & Technical Research Council of Argentina
Location and regulation of acrosomal exocytosis: from in vitro to in vivo observations

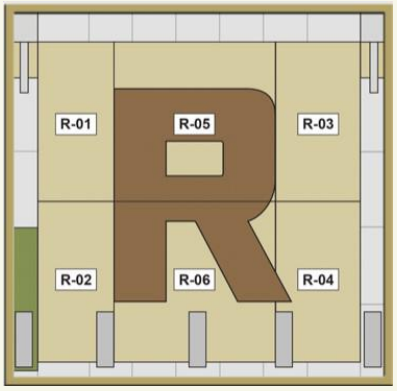
DR. HARI SHROFF
National Institute of Biomedical Imaging & Bioengineering
High speed biological imaging at and beyond the diffraction limit

DR. DIEGO MANTOVANI
Laval University
Nanocoatings, degradable metals and cellularised scaffolds for regenerative medicine

DR. PETER JOHNSON
MedSurgPl, LLC and Scintellix, LLC
Approaching the Complexity of Product Development in Tissue Engineering

CSU BME Alumni Acknowledgement

To provide public acknowledgement of all CSU BME alumni, a CSU On-Campus Stadium Brick with the inscription, *Celebrating Biomedical Engineering Alumni (SBME)*, can be found in Section R-06 on the brick plaza in front of the new football stadium.



New SBME faculty members

Dave Bark, Ph.D., is an assistant professor in the Department of Mechanical Engineering who recently joined the School of Biomedical Engineering. His research interests focus on cardiovascular fluid dynamics and biomechanics, with an aim of understanding how cells produce and respond to forces in a flow environment in relation to cardiovascular disease.

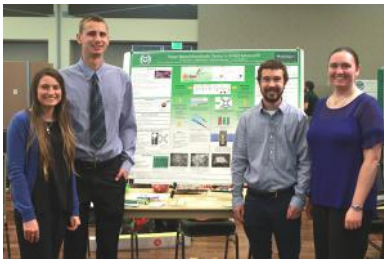
Neha Lodha, Ph.D., recently joined the School of Biomedical Engineering. She is an assistant professor in the Department of Health and Exercise Science and is the Director of the Laboratory for Movement Neuroscience and Rehabilitation. Her research interests include neuromuscular mechanisms of impaired motor control in healthy and diseased populations.

Biomedical Engineering Awards at E-Days

On April 14, 2017, members of the SBME Advisory Board—Dennis Bruner, Julie Dunn, Jeff Samson, Ray Goodrich, Gary Johnson, Steve Simske, Dennis Schlaht, and Jay Srinivasan—served as judges and provided four biomedical engineering teams with cash awards at E-Days, a longstanding annual showcase of capstone senior design projects.

This year, four industry members also served as BME judges—Alan Dean of Beckman Coulter, Khoa Vu and Briden Stanton of Terumo BCT, and Reginald Stilwell of AlloSource—critically evaluating student projects on technical content, presentation, creativity, and overall impression. The following BME student senior design projects were awarded:

First Place: Paper-Based Microfluidic Device for Salmonella Detection (faculty advisor: Chuck Henry)
Team: Maya Kayyali, Sean Visocky, Joe Johnson, and Micki Repasky



The overall goal of this project was to use paper-based microfluidic devices to develop low-cost diagnostic assays to detect Salmonella bacteria and be deployed in developing countries to improve global healthcare. Paper-based microfluidic devices are made from ordinary filter paper that has been patterned to create fluidic circuits. The team redesigned the assay to simplify operation to enable an untrained user to operate the system in the field.

Second Place (tie): Bone Matrix Airbrushing (faculty advisors: Ketul Popat and Matt Kipper)
Team: Mollie Phillips, Michelle Ablutz, Will Raymond, Michael May, and Josh Hayes

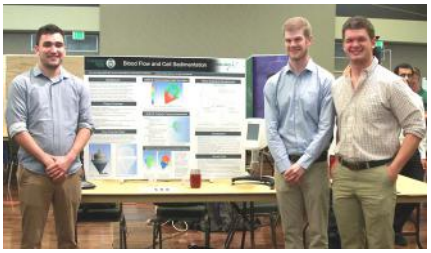
In the design of scaffolds for tissue engineering features at the nanoscale are of particular interest. Natural polymers do not have the processability of synthetic polymers, limiting their ability to mimic the hierarchy of structures in the natural extracellular matrix. Thus, they are often combined with carrier polymers. Demineralized bone matrix (DBM), a natural polymer, is allograft bone with inorganic material removed. DBM contains the protein components of bone, which includes adhesion ligands and osteoinductive signals. In this project, the team developed a novel method for tuning the nanostructure of DBM through electrospinning and airbrushing. Different blends of solvents were explored and viscosity measurements were also made since this is important for electrospinning. Finally, scaffolds were fabricated using optimized electrospinning and airbrushing conditions, and adipose-derived stem cell functionality was evaluated.

Second Place (tie): Fourier Ptychographic Imaging (faculty advisors: Randy Bartels and Ali Pezeshki)
Team: Brandon Kreutz, Nicholas Brown, and Robby Stokoe

The team built a new type of microscope that is capable of high-resolution imaging over a very large field of view. The images were reconstructed using a Fourier Ptychography algorithm based on numerical phase retrieval image reconstruction.

Third Place: Blood Flow and Cell Sedimentation Simulations (sponsor: Terumo BCT)
Team: Jesse Masterson, Ben Bagby, and Mike Hattel

Terumo BCT is interested in improving their simulation abilities related to fluid flow and sedimentation of cells in a high gravity-field, for both anticoagulated whole blood and low concentrations of specific blood cell types. The team worked on scoping what software and computer simulations are used in practice today in both academia and in industry. In parallel, the team attempted to develop a non-hazardous fluid with particles that can simulate blood flow and sedimentation. The team then began using the selected software packages and testing was done comparing the computer simulations as well as the artificial fluid against real blood.



E-Days provides undergraduate engineering students an opportunity to showcase their completed senior design projects to faculty, family, industry representatives, and peers. The capstone senior design project teaches students how to succeed in a well-integrated, interdisciplinary engineering design environment and allows students to develop practical, hands-on skills.

If you are interested in viewing biomedical engineering senior design projects and interacting with our students, please join us for next year's E-Days event on Thursday, April 12, 2018 in the CSU Lory Student Center Ballrooms.

FBI gets synthetic biology crash course at CSU

By Anne Manning

For one week in May, 11 agents and analysts from the U.S. Federal Bureau of Investigation were on campus for an intensive training program spearheaded by one of the university's preeminent biotechnologists. The goal: giving the law enforcement personnel foundational knowledge and insight into the rapidly evolving field of synthetic biology.

Jean Peccoud, the Abell Endowed Chair in Synthetic Biology in the Department of Chemical and Biological Engineering and a core faculty member of the School of Biomedical Engineering, organized the session with the FBI. Peccoud is a computational and cell biologist whose research is in the development of novel DNA molecules, and improving the manufacture of bio-based drugs and vaccines.

At first glance, a relationship between synthetic biology researchers and the nation's top law enforcement agency might seem incongruous. Consider, though, the rapid development of genetic engineering techniques over the last several years. The agents who visited campus were part of the FBI's Weapons of Mass Destruction Directorate, whose purview includes preventing and responding to chemical, biological, radiological and nuclear incidents.

The WMD Directorate is working to build relationships with universities and industry partners to become educated on trends in biological research—from the manufacture of living organism-based vaccines, to the synthesis of new genes in the lab, said William So, Policy and Program Specialist with the FBI's Weapons of Mass Destruction Directorate's Biological Countermeasures Unit. The emergence of big data within the life sciences, and the digitized stores of data that could be vulnerable to cyberattacks, has also pushed the agency to become better versed in these areas. Ultimately, the agency is charged with protecting such systems against terrorism, espionage, or the leaking of proprietary information.

"The amount of research and information in the biotechnology fields is increasing exponentially," So said. "It's important for us to have hands-on experience to better understand how biological experimentation occurs."

The workshop was the first of its kind at CSU. The CSU workshop consisted of lectures on research trends by Peccoud and other CSU experts. It also included blocks of lab time for training participants to perform typical synthetic biology techniques, such as assembling DNA molecules. For example, the trainees used Gibson Assembly to make DNA and transfer it to *E. coli* cells for manufacturing insulin. This lab work was led by Neil Adames, a research scientist in Peccoud's lab.

Peccoud envisions the weeklong training to be offered regularly, and possibly to become available to other federal agencies and corporate partners.

Read full story here: https://source.colostate.edu/fbi-gets-synthetic-biology-crash-course-csu/

Communication workshop helps BME students succeed

On May 9, the School of Biomedical Engineering hosted Eric Wilbur, founder and managing partner of MindShare Advantage, to present a workshop titled "Communication Skills: Jumping from Academia to Industry" to graduate students enrolled in the Walter Scott, Jr. College of Engineering as well as 5th-year undergraduate students in the Biomedical Engineering degree program. In his two-hour presentation, Wilbur discussed how engineers can shift from an audience/trainee mindset to one that focuses on understanding industry needs, including the speaker's context and customer perspective and needs.

Engineers are often brilliant, detail-oriented people who are experts at research, design, and innovation. And while these skills are crucial in solving engineering problems and creating industry products, they do not automatically lead to effective communication. Since the ability to communicate ideas, research, and solutions is the key ingredient to career development and advancement, SBME hosted the workshop to give students an opportunity to acquire knowledge of ways in which they can develop their communications skills. Students who attended learned and experienced key concepts that they will be able to utilize to transform information into meaningful communication that helps them connect with their audience. Wilbur discussed how they, as speakers, can approach technical communications from their audience's perspective—using meaningful audience dialogue, building trust, and uncovering hidden opportunities—rather than pushing technical knowledge and details.

With a background that includes over 25 years of industry experience in engineering and knowledge of technical training and instructional design, Wilbur has extensive experience collaborating with teams of technical instructors, design engineers, field sales/applications engineers, and marketing managers. In this workshop, he transferred essential teaching and workshop facilitation skills to our engineering trainees.

Tinker, soldier, engineer: one veteran student's journey

By Syl DeLeon

"I like to tinker with things," said Edwin Vasquez, a graduate of Colorado State University's online master's in biomedical engineering, when talking about his career path. But his skills go far beyond that.

Vasquez served in the U.S. Navy for more than a decade, troubleshooting generators for aircraft and portable turbines. After graduating with his master's, he made the transition to biomedical engineering. Now he uses his propensity for "tinkering" to oversee machines that offer life-saving benefits to other veterans at the Veteran Affairs (VA) hospital in Orlando, Florida.

Edwin Vasquez

"I like to fix things, too," he said. "I like being able to struggle with something because at the end of it, once I find a solution, I have this immense satisfaction from being able to do that, not just for me, but for whoever I had to solve the problem for."

Biomedical engineering integrates the fields of biology and medicine with engineering solutions. It offers a transdisciplinary focus on improving health, fighting disease, and aiding people with disabilities. CSU's online program helped Vasquez use his math and problem-solving background to shift into the medical field, and pursue his passion of serving those who served.

"I was in the first Gulf War in the early 90s, in Saudi Arabia," he said. "Some of the guys I knew, they didn't make it back, or lost something. It's the passion I feel for these guys that I serve now, and I see them here every day, missing limbs... that's who I work for now."

To learn more about Vasquez, his work at the VA, and CSU's online biomedical engineering master's program, watch the video online at https://source.colostate.edu/tinker-soldier-engineer-one-veteran-students-journey-aviation-medical-technology/.

2017/18 Scholarship winners

Awarded to students with an interest in biomedical sciences or engineering, this year's **Joan C. King Memorial Scholarship Award** was given to Patricia Stasiowski and Savannah Sandvick, at the Women of Vision Gala in July, hosted by the Colorado Women of Influence.

Stasiowski, a third-year student at CSU, is vice president of the CSU International Society of Pharmaceutical Engineers and a member of Kappa Kappa Gamma.

Sandvick, a biomedical science student at CSU, is looking to become a physician's assistant in the field of orthopedics.

Tyler Daniels received the **SBME Scholarship for Leadership and Innovation** for the 2017/18 school year. This scholarship was created to support biomedical engineering students who show a commitment to leadership and excel as creative problem-solvers.

Daniels gained leaderships skills working in the Therapeutic Materials and Biointerface Research Laboratory at CSU, achieved the Eagle Scout rank in the Boy Scouts of America, and serves as a resident assistant on campus.

SBME Faculty, Staff & Student Research & Awards

Lab works to revolutionize tissue regeneration in injured patients

Matt Kipper

By Sona Srinarayana

Matthew Kipper's lab is currently incorporating electrospinning into research for biomedical applications. His work was recognized by the Musculoskeletal Transplant Foundation in 2011, and he continues to make strides with this research.

Biomedical engineering graduate student Raimundo Romero is currently working on replicating native bone tissue structure to enhance bone graft healing in injured patients.

"In our lab, we use electrospinning as a way to create materials that can be used to deliver therapeutic proteins and stem cells for tissue regeneration. By delivering the right signals to the injured tissue, we can enhance the tissue healing response to heal injuries to tissues that may not otherwise heal by themselves," Romero said.

The electrospinning technique is being used because of its ability to manufacture materials with microscopic dimensions and large surface areas for an array of unique applications. More specifically, electrospinning creates nanofibers, or ultra-thin fibers, in various configurations. The process uses an electrical field to draw a charged polymer solution from a syringe, which is then deposited on a grounded collector.

In addition to this project, Kipper and Ketul Popat, associate professor in the Department of Mechanical Engineering and core faculty member in the School of Biomedical Engineering, recently involved two chemical and biological engineering undergraduate senior design teams for the advancement of other electrospinning applications. One team worked to optimize the process of electrospinning demineralized bone matrix onto a mat for the creation of scaffolds for cell growth, and another team designed a new process for the production of engineered tissues.

Full story: https://engr.source.colostate.edu/lab-works-revolutionize-tissue-regeneration-injured-patients/

Bacterial biofilms, begone

By Anne Manning

By some estimates, bacterial strains resistant to antibiotics – so-called superbugs – will cause more deaths than cancer by 2050. Colorado State University biomedical and chemistry researchers are using creative tactics to subvert these superbugs and their mechanisms of invasion. In particular, they're devising new ways to keep harmful bacteria from forming sticky matrices called biofilms – and to do it without antibiotic drugs.

Researchers in the laboratory of Melissa Reynolds, associate professor in the Department of Chemistry and core faculty in the School of Biomedical Engineering, have created a new material that inhibits biofilm formation of the virulent superbug *Pseudomonas aeruginosa*. Their material, described in *Advanced Functional Materials*, could form the basis for a new kind of antibacterial surface that prevents infections and reduces our reliance on antibiotics.

Bella Neufeld, the first author and graduate student who led the research, explained that her passion for finding new ways to fight superbugs is motivated by how adaptive and impenetrable they are, especially when they are allowed to form biofilms. "Biofilms are nasty once they form, and incredibly difficult to get rid of," Neufeld said.

Reynolds' research group makes biocompatible devices and materials that resist infection and won't be rejected by the body. In this most recent work, they've designed a material with inherent properties that keep a bacterial film from forming in the first place.

In the lab, they demonstrated an 85 percent reduction in *P. aeruginosa* biofilm adhesion. They conducted extensive studies showing the reusability of their film. This indicated that its antibacterial properties are driven by something inherent in the material, so its efficacy wouldn't fade in a clinical setting.

Chitosan is already widely used as a wound dressing and hemostatic agent. Neufeld says the new biomaterial could form new avenues for antibacterial surfaces. For example, the material could be used for a wound dressing that, instead of gauze, would be made of the chitosan matrix.

Read full story here: https://source.colostate.edu/bacterial-biofilms-begone/

Brett Eppich Beal receives Jack E. Cermak Advising Award

The 2017 *Celebrate!* Colorado State Awards were presented to outstanding members of the Ram Family on April 18. Senior Undergraduate Academic Advisor Brett Eppich Beal received the Jack E. Cermak Advising Award, which was created in 1984 to honor excellence in academic advising, including recognition by students and peers as an outstanding advisor, capacity to offer career as well as academic advising, interpersonal communication skills that lead to beneficial advising relationships, and contributions to the improvement of advising services and/or the appreciation of academic advising throughout the campus.

BME students receive awards at CURC 2017

Jacqueline Foss

CURC, the annual *Celebrate Undergraduate Research and Creativity Showcase,* is held each April to recognize and honor student achievements and showcase what they have learned as a result of their scholarly research, scientific inquiry, and/or creative endeavors.

BME students Kat Killingsworth, Colleen Jones, Jordan Bernhardt, Lindy Gillette, and Ryan Leuenberger received High Honors at the CURC Awards Ceremony on April 25 for their research poster, *The Canine Exoskeleton*.

Jacqueline Foss, biomedical engineering student and president of the BMES Student Chapter, received one of six "Best in Show" awards for her research titled, *Studying shape changes of cancer cell lines with different degrees of invasiveness on hydrophobic and hydrophilic substrates using multivariate methods.* "I learned a great deal about lab processes and protocols from my involvement in research and, through my contribution, I was able to present at both the American Society of Cell Biology National Conference as well as the CURC event," Foss said.

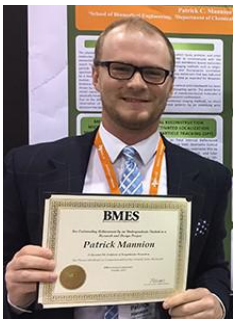
CSU BME students showcase research at BMES Annual Meeting

This year's BMES Annual Meeting took place in Phoenix, Arizona on October 11 - 14. The BMES Annual Meeting is the largest event for the biomedical engineering and bioengineering fields. CSU was well represented at the meeting by an assortment of undergraduate and graduate students, as well as faculty and staff.

McKennah Repasky

Two students took home awards including McKennah Repasky who, on behalf of her teammates Joseph Johnson, Maya Kayyali, and Sean Visocky, accepted Honorable Mention for the Design by Biomedical Undergraduate Teams (DEBUT) Challenge presented by the National Institute of Biomedical Imaging and Bioengineering for her team's superior design on their *Paper-Based Microfluidic Device to Detect Salmonella*.

The second student to win an award was Patrick Mannion. He took home an award for Outstanding Achievement by an Undergraduate Student in a Research and Design Project for his poster project, *The Plasma Membrane is Compartmentalized by a Fractal Actin Meshwork*.



Patrick Mannion

The following research posters were on display at the meeting:

- ***An Electrochemical Biosensor System for Visualization of Neurotransmitter Gradients in Live Tissue with High Spatiotemporal Resolution*** by Jasmine Nejad
- ***3D-Printed Microfluidic Device for the Analysis of Intestinal Tissue Ex Vivo*** by Ian McLean and Luke Schwerdtfeger
- ***Model-Driven Design of Single-Cell Experiments*** by Zach Fox
- ***Zika Virus Infection Detection Using a Paper-based Analytical Device*** by Lei Wang
- ***Pharm Cat: A Physiologic-based Pharmacokinetic (PBPK) Model to Study Virtual Drug Dosing in Cats*** by Renee Lake, Jessica Quimby, and Brad Reisfeld
- ***Standardization of the Jaipur Foot Manufacturing Process*** by Aidan Friederich, Daniel Palmer, and Kylie Rembert
- ***Time Correlated Single Photon Counting using an FPGA Board*** by Anthony Zilinsky

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Save the Date

OCTOBER 2017

SBME Seminar: Dr. Mark Borden, UC Boulder
Oct. 30 | 103 Behavioral Sciences | 12–12:50 p.m.

NOVEMBER 2017

SBME Seminar: Brett Steineman & Yanyi Zang, Ph.D. students
Nov. 6 | 103 Behavioral Sciences | 12–12:50 p.m.

SBME Seminar: Dr. Ashok Prasad, CSU
Nov. 13 | 103 Behavioral Sciences | 12–12:50 p.m.

SBME Seminar: Hieu Bui & Jasmine Nejad, Ph.D. students
Nov. 27 | 103 Behavioral Sciences | 12–12:50 p.m.

DECEMBER 2017

SBME Seminar: Dr. Bruce Tromberg, UC Irvine
Dec. 4 | 103 Behavioral Sciences | 12–12:50 p.m.

BME Fall Commencement
Dec. 16 | Lory Student Center | 12:30 p.m.

Scholarships

Scholarship support at all levels provides critical aid to our students. We strive to help as many students as possible with the financial obligations of their engineering education.

Donate to an SBME scholarship today and know that your gift will make an impact for years to come.

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https://advancing.colostate.edu/SBME

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