VISIONARY MATERIALS: THE EVOLUTION AND IMPACT OF OPHTHALMIC BIOMATERIALS

TOOLS AND STRATEGIES FOR MEANINGFUL AND MEASURABLE RESEARCH IMPACT

BIOMATERIALS FORUM

OFFICIAL NEWSLETTER OF THE SOCIETY FOR BIOMATERIALS

THIRD QUARTER 2025 • VOLUME 47, ISSUE 3

ALSO INSIDE

BIOMEDICAL TEXTILES AT NC STATE

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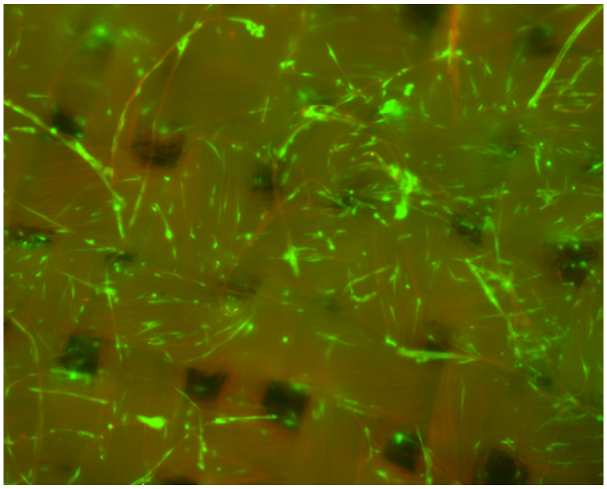
Contact information can be found on individual SIG pages as found **here**.



ON THE COVER

Viability of human dermal fibroblasts on a simple woven hemp fabric structure is shown (live=green, dead=red). This project supported by the NSF Textile Innovation Engine explores the potential use of hemp fibers for wound healing applications. Our preliminary work, led by Kaleah Gaddy, demonstrates hemp fibers exhibit basic biocompatibility and ongoing studies are being conducted by the Gluck Tissue Engineering Laboratory at North Carolina State University.

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From the Editor

By Roger Narayan, MD, PhD, Biomaterials Forum Executive Editor

Welcome to the Third Quarter issue of the Biomaterials Forum!

Joyce Wong highlights opportunities for the biomaterials community to support each other both regionally and nationally in her President's Letter. These include the 2026 Annual Meeting call for abstracts; Biomaterials Day applications; the Cato T. Laurencin, MD, PhD Undergraduate Travel Fellowship; and the Dr. C. William Hall Award.

The AIMBE update highlights activities at the 2026 AIMBE Annual Event, which includes visits with members of Congress and their staffs as well as a Research Blitz showcase for Fellows and Emerging Leaders.

Our feature articles cover recent developments from the Society For Biomaterials community involving biomaterials research and translation. Kiran M. Ali, Mahtab Khodadadi, Kaleah Gaddy, Melissa Sharp and Jessica M. Gluck describe biomedical textile research at North Carolina State University, including fiber-based scaffolds for cardiac tissue engineering and corneal tissue engineering.

Katelyn Swindle-Reilly reviews the evolution of ophthalmic biomaterials from early intraocular lenses to current therapeutic delivery systems. This article also considers the development of ocular biomaterials at The Ohio State University.

Arpita Shome and Hitesh Handa discuss surface modification strategies, including the combination of passive antifouling surfaces and bioactive components.

Janice D. McDonnell and Susan D. Renoe outline methods for documenting research impact and demonstrating translational outcomes to funding agencies and institutional leadership.

Student News celebrates the appointment of three new student officers: Shatil Shahriar, Nicole Racca and Andie Tubbs. Member News recognizes significant achievements by Guillermo Ameer, Emily Day, Binata Joddar, Cato T. Laurencin, Nicholas Peppas, Aliasger Salem and Samuel Sung. The Industry News provides a comprehensive overview of market growth trends in the global biomaterials market. Government News considers updates on the federal budget process, including NIH oversight of foreign research collaborations, NIH rules on AI use and the number of applications per investigator per calendar year, as well as the Aug. 7, 2025 White House Executive Order on Federal Grant Oversight.

Please feel free to contact me at roger_narayan@ncsu.edu if your group would like to share biomaterials research, education and translation efforts of interest to the Society For Biomaterials community. The submission of news items, updates and cover images is always welcome.

CALL FOR COVER ART

WE WANT TO FEATURE YOUR EXCITING BIOMATERIALS ARTWORK ON THE COVER OF *BIOMATERIALS FORUM!*

Deadline: Accepted on a rolling basis.

Instructions: Please email artwork (digital images, artistic creations, etc.) to info@biomaterials.org, to the attention of the Executive Editor of the *Biomaterials Forum.* All artwork with biomaterials relevance that have not appeared as a *Forum* cover are welcome. Multiple submissions are permissible.

Description: Selected artwork will appear as the cover of a future issue of *Biomaterials Forum* along with a brief "On the Cover" description of the subject and name/affiliation of the creator.

Format: High-resolution electronic version in .gif, .tiff or .jpeg file format.

From the President

By Joyce Wong, SFB President

Dear SFB Members,

I hope you've all found time to recharge during the summer months. As we enter a new academic year filled with fresh opportunities for trainees and mentors, industry professionals are likewise launching innovative projects and partnerships that will drive our field forward. Government researchers and funding agencies are also setting priorities that will shape the future of biomaterials research.

In these uncertain times, when research funding faces unprecedented challenges, our community's greatest strength lies in our unwavering support for one another. This support extends far beyond SFB's boundaries. In July, I had the privilege of attending the Friends of NIBIB roundtable sponsored by AIMBE, where leaders from different scientific societies came together to voice our concerns and identify collaborative opportunities to advocate for biomaterials and biomedical research. These cross-sector partnerships are essential as we navigate funding uncertainties and work to demonstrate the transformative impact of our field.

I am pleased to report that the various SFB committees are working diligently to serve our broad membership – from academic researchers and industry innovators to government scientists and regulatory professionals. Below, I highlight several opportunities where we can continue supporting each other both regionally and nationally, strengthening the bonds that make our community resilient in the face of these challenging times.

2026 ANNUAL MEETING – CALL FOR ABSTRACTS

Please think about how you can contribute to our next annual meeting, "*Biomaterials at the Crossroads: Connecting Science, Industry, and Innovation*," scheduled for March 25-28, 2026, in Atlanta, GA., organized by co-chairs Dr. Angela Throm (Medtronic) and Dr. Susan Thomas (Georgia Institute of Technology). Please submit your abstracts – the call for abstracts portal opens Sept. 15.

BIOMATERIALS DAY APPLICATIONS DUE OCT. 20, 2025

Thank you to the SFB staff who have been working hard to update the SFB student chapter information. Please consider **hosting or attending a regional Biomaterials Day** to connect with peers, share research and build collaborations. Consider inviting the broader community. **Please note that applications for 2026 Biomaterials Day funding are due Oct. 20, 2025.** Learn more and apply here**.**

NOMINATIONS OPEN FOR UNDERGRADUATE AWARDS (DEADLINE: DEC. 3, 2025)

Cato T. Laurencin, MD, PhD Undergraduate Travel Fellowship**:**
Named in honor of a distinguished member of the Society For Biomaterials, Cato T. Laurencin, MD, PhD, the Undergraduate Travel Fellowship will support underrepresented minorities in the field of biomaterials by providing an undergraduate student the resources to attend the annual meeting of the Society For Biomaterials, and to become a member of the Society. The goal of this initiative is to stimulate/encourage recipients to pursue a career in biomaterials.

Dr. C. William Hall Award**:**
This award honors the memory of the Society's first president, Dr. C. William Hall. This student scholarship is awarded to a junior or senior undergraduate pursuing a bachelor's degree in bioengineering or a related discipline focusing on biomaterials.

Together, we are strong, and together, we can support each other and advance the promise of biomaterials, especially during these uncertain times.

Yours in solidarity and with gratitude,

Joyce Y. Wong, PhD
Professor of Biomedical Engineering and Materials Science & Engineering, Boston University
President of Society For Biomaterials

AIMBE Updates

AIMBE PUBLIC POLICY WORKSHOP FOR TRAINEES

AIMBE's highly acclaimed two-day Public Policy Institute was held on Oct. 27-28, 2025 in Washington, DC. Students heard from public policy experts, industry representatives and senior leaders at advocacy think-tanks about the policy landscape shaping the scientific enterprise. More information is available online at www.aimbe.org/institute.

REGISTRATION NOW OPEN FOR AIMBE'S 2026 ANNUAL EVENT

Registration is now open for the 2026 AIMBE Annual Event taking place April 11-13, 2026. This year's gathering will once again bring together leaders across medical and biological engineering to celebrate our community, advance advocacy and share groundbreaking science.

One of the most impactful aspects of AIMBE's Annual Event is the opportunity to participate in congressional visits with your members of Congress and their staff. There has never been a more important time to advocate for science and engineering on Capitol Hill. AIMBE will provide all participants with training, talking points and transportation to Capitol Hill. Space for these visits is limited, so early registration is strongly encouraged.

We also invite Fellows and Emerging Leaders to showcase their work during the popular Research Blitz – a limited opportunity to deliver a rapid, five-minute talk highlighting your research.

Beyond advocacy and research, the Annual Event will celebrate AIMBE's newly elected Fellows and award recipients, feature inspiring science talks and provide updates on the latest public policy developments shaping the future of medical and biological engineering.

We hope you will join us in DC for this special event. Register today and be part of AIMBE's mission to champion innovation, advocacy and community.

Student News

The National Student Chapter held its officer elections this past summer and is pleased to announce the appointment of three new student officers: Shatil, Nicole and Andie. Their diverse backgrounds and dedication will contribute greatly to the Society and the National Student Chapter's mission and activities. Brief introductions are provided below:

Shatil Shahriar: President-Elect

Sharil Shahriar is a PhD candidate in the Department of Surgery at the University of Nebraska Medical Center. His research focuses on developing medical devices for soft tissue repair and regeneration, minimally invasive delivery, cell collection and hemorrhage control. He joined SFB to connect with a community that bridges biomaterials innovation and clinical translation, and was inspired to join the National Student Chapter to help foster collaboration and mentorship among young researchers.

Nicole Racca: Secretary/Treasurer-Elect

Nicole Racca is a fourth-year PhD student in Biomedical Engineering at the University of Michigan in Dr. María Coronel's laboratory. She is focused on developing immunomodulatory micron-sized biomaterials with augmented signaling through enhanced binding kinetics. She has joined SFB due to her fascination with biomaterials engineering and the innovative role these discoveries may play in the world of healthcare, and is excited to be a part of the National Student Chapter to get involved in the community with like-minded individuals.

Andie Tubbs: Bylaws Chair

Andie Tubbs is a second-year PhD student in Biomedical Engineering at the University of Memphis (BIOME Lab, Dr. J. Amber Jennings). He researches electrospun and microparticle-based chitosan biomaterials for sustained, targeted drug delivery in Hypermobile Ehlers-Danlos Syndrome. As Bylaws Chair of the SFB National Student Chapter, Andie draws on extensive leadership experience to steward clear, accessible bylaws that catalyze interdisciplinary collaboration, leadership development and forward-thinking innovation across the student community.

If you have any questions, require any information or have suggestions for improved services, please feel free to contact the Society's Headquarters office:

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Biomedical Textiles at NC State

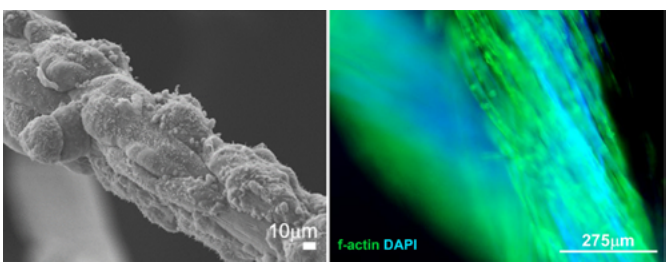
By Melissa Sharp, Kiran M. Ali, Mahtab Khodadadi, Kaleah Gaddy and Jessica M. Gluck

INTRODUCTION

Medical textiles are specialized fibrous materials designed for use in healthcare and biomedical applications. These include wound dressings, surgical meshes, sutures, implantable scaffolds and wearable diagnostic fabrics. Their unique fibrous structure offers advantages such as flexibility, high surface area, tunable porosity and the ability to mimic the extracellular matrix (ECM), making them particularly beneficial in tissue engineering and regenerative medicine.

Textiles in medicine date back centuries, with natural fibers such as cotton and silk traditionally employed in bandages and sutures. Significant advancements occurred in the 20th century with the introduction of synthetic polymers, enabling greater control over mechanical properties and sterilization. More recently, the integration of bioactive, biodegradable and smart materials has expanded the role of medical textiles in advanced therapeutic and diagnostic systems.

As the field continues to evolve, medical textiles remain at the forefront of innovation, creating new possibilities in cell delivery, guided tissue regeneration and responsive biomedical devices. Wilson College of Textiles at North Carolina State University is an excellent home for medical textile research and innovation.



From Ali KM et al. Polymers, 2022; 14(10): 2100. Collagen fibers exhibit biocompatibility with NIH 3T3 fibroblasts. A) Electron micrograph depicts cells proliferating along the length of a single collagen fiber (scale bar = 2µm). B) F-actin (green) of cells (nuclei=blue) is shown as they proliferate along the circumference of the collagen fiber (scale bar = 275µm).

APPLICATIONS OF MEDICAL TEXTILES

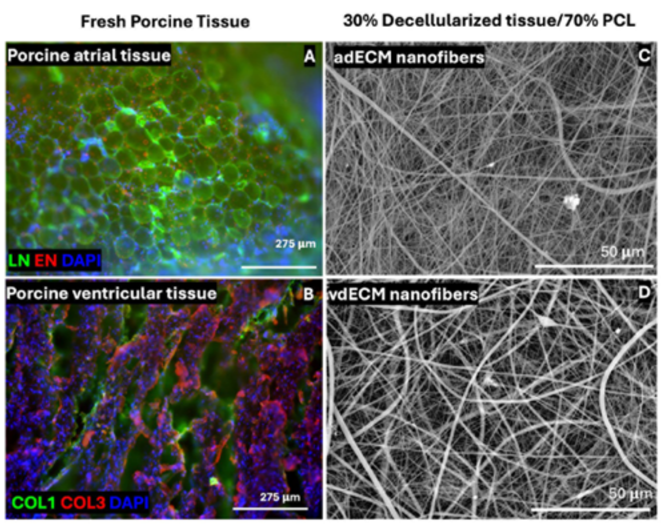
Medical textiles span a wide range of applications, from enhancing hygiene and comfort — such as antimicrobial car seats and breathable sportswear — to treating injuries with wound dressings and replacing damaged tissues using implantable prosthetics such as artificial arteries or heart valves. These textiles also play vital roles in injury prevention (e.g., wrist supports), infection control (e.g., face masks), disease containment (e.g., surgical gowns), drug delivery (e.g., nicotine patches) and regenerative medicine (e.g., tissue engineering scaffolds).

One of the most recognizable medical textiles is the vascular graft. A vascular graft is a fibrous structure used to both redirect blood flow and provide structural support to weakened vessels and arteries. The history of biomedical textiles at NC State began with a pioneering breakthrough: the development of the first artificial aorta. While serving as the head of the knitting department at the College of Textiles in 1955, Dr. William Edward Shinn developed the design and fabrication of knitted structures to serve as replacements for aortas. Using a knitted structure provided more flexibility than previous woven designs. The basic design developed at the college can be found within current synthetic vascular grafts commercially available today. In fact, the artificial aorta project laid the foundation for a unique research ecosystem in which material science, biomedical engineering and textile technology converge to create solutions with medical applications. From that initial success, NC State has grown into a hub for implantable and surgical biotextiles, producing high-performance materials including vascular grafts, surgical sutures, hernia meshes and embolic filters that are biocompatible, durable and resorbable and that are designed to integrate seamlessly with human tissue and reduce surgical complications. Textiles faculty at NC State in the 1960s and 1970s were among the first to design textile-based vascular grafts, including the Dacron artificial aorta, for commercial use, basing their designs on Shinn's previous success. The advances in vascular graft design and fabrication from the College of Textiles between 1950 and 1990 helped the technology improve and become ubiquitous in the treatment of heart disease globally.

Building on this strong foundation, Dr. Martin W. King, a long-time SFB member and contributor, has advanced the field of biomedical textiles at NC State since joining the faculty in 2000. He significantly expanded the application of textile science beyond vascular grafts to include a broad range of implantable and surgical biotextiles, emphasizing the importance of fiber structure, porosity and surface modification for biocompatibility and function. King played a key role in bridging academic research with clinical application, helping to develop materials for tendon repair, surgical meshes, stent grafts and more. His contributions not only strengthened NC State's leadership in medical textiles but also shaped global standards for how engineered fabrics are used in regenerative medicine and surgical care. For the past 25 years, King has worked with Dr. Gregory Ruff, a plastic surgeon affiliated with Duke University, in the area of barbed sutures, which have experienced great success in outpatient cosmetic surgery. Additionally, Dr. Jessica M. Gluck, a former MS student of King's, joined the faculty in 2019 and has advanced NC State's reputation in biomedical textiles through her research focused on how the cellular microenvironment influences tissue development and function. Her research group designs tunable biomaterials to analyze cellular responses, particularly in the areas of cardiac and corneal tissue engineering.

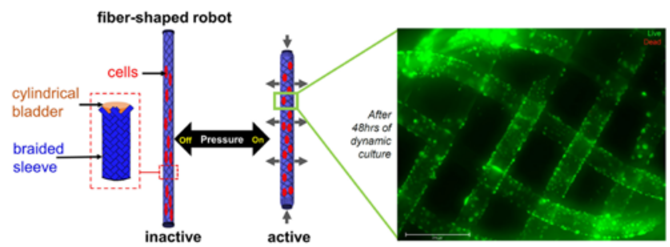
CURRENT EXAMPLES OF BIOMEDICAL TEXTILE RESEARCH AT NC STATE

The BioMedical Textile (BMT) Research Group was founded by King in 2000 and is currently led by King and Gluck. Their current research focuses on the use of fibrous materials in tissue engineering, with additional projects in collaboration with industry sponsors. King has a long history of working with industry to analyze and improve existing, commercially available products, including barbed sutures, hernia repair meshes and vascular grafts. Gluck takes more of a basic science approach to understand the fundamentals of how individual elements of the microenvironment work in conjunction to generate a specific cellular response. King and Gluck hope to leverage their knowledge to design better biomaterials to guide both stem cell differentiation and enhance cellular function. The BMT group has a long history of working collaboratively with partners across NC State's campus, particularly with faculty at the College of Veterinary Medicine and collaborators across the globe.



Decellularized cardiac tissue can be fabricated into fibrous scaffolds. A) Porcine atrial tissue exhibiting laminin (LN, green), elastin (EN, red), Nuclei (blue). B) Electrospun fibers made from 30% w/v atrial dECM with 70% w/v polycaprolactone (PCL). C) Porcine ventricular tissue exhibiting collagen I (COL1, green), collagen III (COL3, red), Nuclei (blue). B) Electrospun fibers made from 30% w/v ventricular dECM with 70% w/v polycaprolactone (PCL).

Over the past 50 years, Wilson College's research has expanded from developing textile materials for healthcare and medical uses to exploring how fibrous materials can be used medically, both commercially and as 3D models to better understand biological questions. In particular, the use of fibrous structures to mimic the fibrous nature of the ECM has led to the development of new materials. Over the past six years, Gluck's Tissue Engineering Lab has focused on how the microenvironment influences cellular differentiation and function. The research team has used fibrous materials to recapitulate the microenvironment and ECM in efforts to isolate individual properties of the microenvironment to analyze specific cellular responses. Gluck's background in molecular, cellular and integrative physiology brings a unique perspective to medical textile research at Wilson College, bridging the rich tradition in materials science and engineering with advancements in understanding of cellular processes; this has led to the development of new materials that mimic the fibrous nature of ECM. By focusing on how the microenvironment influences cellular differentiation and function, her lab has used fibrous materials to recapitulate the microenvironment and ECM to isolate, elicit and analyze specific cellular responses. This work is currently focused on cardiac and corneal tissue engineering in the Gluck Lab.



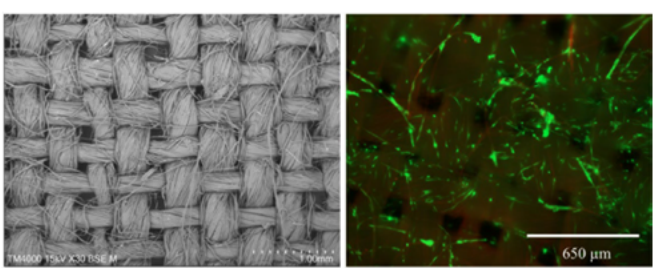
From Hoque MA et al, Biomimetics, 2023: 8(2): 170. Fiber-shaped "robots" were developed as a method of creating 3D dynamic cell culture systems. These fiber-shaped robots demonstrated their biocompatibility with cells exposed to 48 hours of continuous dynamic culture conditions.

CARDIAC TISSUE ENGINEERING

Decellularized extracellular matrix (dECM) retains the native biochemical and structural cues of tissues and has emerged as a powerful material for guiding stem cell fate. Gluck Lab created electrospun scaffolds using dECM coaxially (core-sheath fiber configuration) and conventionally. In a current project, the idea of driving heart-chamber-specific differentiation using dECM derived from both the atria and the ventricle of the porcine heart is being explored. The dECM material was electrospun to create nanofibrous scaffolds to recreate the fibrous nature of the ECM. Upon analysis of the native tissue from the native heart chambers, different protein compositions were defined based on the specific physiological roles of the different heart chambers. The resulting chamber-specific dECM scaffolds translated into material-level distinctions, including variations in fiber architecture, stiffness and protein adsorption profiles. When pluripotent stem cells were seeded on these chamber-specific scaffolds, early differentiation markers and functional outcomes showed alignment with the source tissue, indicating that the biochemical identity of the ECM plays a direct role in directing cardiomyocyte fate.

This approach highlights the potential of regionally tailored biomaterials to achieve more precise and physiologically relevant cardiac tissue models and underscores the importance of considering native tissue heterogeneity in scaffold design for regenerative medicine. The ability to include dECM in a coaxial (core-sheath) fiber configuration paves the way for additional control over the mechanical properties of the resulting scaffolds while preserving the advantages of the native tissue. These results underscore the critical role of biochemical surface composition — particularly the inclusion of cardiac dECM — in directing cell fate and minimizing residual somatic memory during iPSC-CM differentiation.

Another aspect of the microenvironment the lab has explored is electrochemical signaling. To provide electrical stimulation, conductive scaffolds were developed from both electrospun polycaprolactone and aligned carbon nanotubes. These scaffolds exhibited significant conductivity and were confirmed to be biocompatible with both a generic human cell line and human stem cell-derived cardiomyocytes. After establishing the initial biocompatibility of the conductive scaffolds, a novel bioreactor system was developed to provide controlled external electrical stimulation, which can simulate clinically relevant electrophysiology. The applied voltage was optimized to ensure cardiomyocytes isolated from neonatal rats would retain their beating function. During the preliminary tests, it was observed that the neonatal rat cardiomyocytes not only survived exposure to external stimulation, but retained their function and showed increased expression of cardiomyocyte markers. Initial results using human pluripotent stem cells indicate external stimulation applied during the differentiation process can improve the derivation of a mature cardiomyocyte phenotype. This example highlights how fibrous materials can be used to mimic individual aspects of the microenvironment to explore its impact specifically on cardiomyocyte differentiation and function.



Hemp fibers support cellular adhesion and proliferation (left), and simple woven fabric made from 100% hemp fibers (right) (scale bar = 1mm). LIVE/DEAD analysis of human dermal fibroblasts after seven days of maintenance exhibit proliferation patterns mimicking the woven structure.

CORNEAL TISSUE ENGINEERING

Gluck Lab brings a similar focus on the microenvironment to corneal tissue engineering. The outermost layer of the cornea is the corneal epithelium, comprising the ocular surface. Gluck Lab's focus is on how to improve wound healing of injuries and diseases afflicting the ocular surface through the use of fibrous materials and to better understand how to derive corneal tissues for regenerative medicine.

Ocular surface regeneration is controlled by limbal stem cells, which are a progenitor cell population controlling regeneration of corneal epithelium. One material used in surgical intervention to assist in ocular surface wound healing is the amniotic membrane, which is an avascular membrane derived from placental tissue. In both humans and animals, amniotic membrane is the gold standard of fibrous constructs, used for cell delivery to repopulate afflicted corneal tissues and to encourage corneal wound healing. Gluck Lab demonstrated that commercially available amniotic membrane is compatible with pluripotent stem cell-derived limbal stem cells. The amniotic membrane demonstrated its ability to support both a progenitor cell state as well as more terminal differentiation toward a corneal epithelial cell population.

Gluck Lab researchers developed a synthetic fibrous mesh to use as a substitute for amniotic membrane, which will be the first commercially available synthetic substrate specifically for ocular surface repairs in a veterinary population. This mesh is an electrospun scaffold made from poly(lactic-co-glycolic acid) (PGLA) with a modified surface, which has been demonstrated to work as well as if not better than amniotic membrane. This product is the Gluck's Lab's first project to undergo the path to commercialization and will target veterinary use first. It is thought that the synthetic fibrous biomaterials created by Gluck Lab researchers closely mimic that of the fibrous nature of the stroma found in the middle layer of the cornea, enabling a biomimetic microenvironment that can support both corneal-specific differentiation and function.

In addition to supporting ocular surface regeneration, fibrous scaffolds were developed that can be used as drug-delivery vehicles to enhance ocular surface wound healing. Using electrospun scaffolds with simple dip-coating, the scaffolds demonstrated they can deliver the recombinant protein Noggin to support wound healing with corneal epithelial cells. Deficiencies in Noggin protein have been implicated in recalcitrant corneal ulcers and defects due to its effects on molecular pathways responsible for cellular proliferation and migration. This works the ability of fibrous scaffolds to both deliver small molecules and drugs to leverage existing pathways to encourage wound healing, and creates synthetic fibrous microenvironments similar to native tissue also enhancing native wound healing processes.

GENERAL TISSUE ENGINEERING

The learnings and principles derived from the work on cardiac and corneal tissue engineering has demonstrated that leveraging the fibrous nature of medical textiles can be used to mimic native ECM and, when combined with stem cells, can drive differentiation to study the differentiation process as well as potentially replace damaged and/or diseased tissues through tissue engineering and regenerative medicine. The BMT group and the Gluck Lab's research extends to addressing other key areas to advance the science of tissue engineering and bring the resulting technologies to patients more quickly.

ADVANCEMENTS IN IN VITRO ENVIRONMENTS

Creating realistic in vitro environments is critical for advancing tissue engineering. Traditional static cultures fail to capture the dynamic mechanical cues present in native tissues like muscle, heart and vasculature. To address this, a pneumatic fiber-shaped robot was developed as a mechanically active scaffold that provides cyclic strain to cells grown on its surface in collaboration with Dr. Xiaomeng Fang's group. The system consists of a braided textile sleeve surrounding a soft, inflatable core. Upon pneumatic actuation, the scaffold contracts, simulating the mechanical environment of living tissue. This motion introduces a 3D culture platform with controlled, repeatable movement, offering a new tool to study cellular mechanobiology. Dynamic loading was confirmed to support cell health at optimized strain levels, while excessive strain reduced viability, highlighting the importance of tuning mechanical inputs. With further refinement, it holds promise for applications in regenerative medicine, disease modeling and the development of mechanically conditioned tissues.

BREAKTHROUGHS WITH INDUSTRY PARTNERSHIPS

In addition to challenges in creating realistic in vitro environments, another roadblock to commercially producing tissue engineering solutions is the lack of ability to manufacture the materials at industrial scale. Collagen is a go-to material for tissue engineering; however, scaling it up into mechanically robust and biologically active structures remains a significant challenge. In this example, bovine-derived collagen fibers — generously provided by Kaneka Corporation — were processed into micron-scale yarns using a traditional ring-spinning method. Unlike typical lab-scale fabrication, this method mirrors large-scale textile manufacturing, offering a rare combination of biocompatibility and industrial scalability. Imaging confirmed that cells (fibroblasts) not only adhered but also aligned along the yarn structure — an important feature for tissues such as muscle, tendon or skin. What makes these collagen yarns exciting is their mid-scale diameter — larger than nanofibers, but still small enough to support cellular behavior. Most importantly, the use of standard spinning methods opens the door for mass production — a key step in making bioengineered scaffolds more accessible and affordable.

Additional inquiry has focused on using alternative natural fibers for tissue engineering applications. Specifically, a partnership with the NSF Textile Innovation Engine was established to explore using hemp-derived fibers for skin tissue engineering applications. Hemp is a biodegradable material demonstrated to be biocompatible with human dermal fibroblasts. Human dermal fibroblasts were found to adhere and proliferate on the hemp-derived fibrous materials well and future work will explore how different fabrication designs influence cellular behavior.

ADDITIONAL BIOMEDICAL TEXTILES USES

Biomedical textile research at NC State's Wilson College is wide-ranging. Additional research areas include the continued optimization of barbed suture fabrication, the development of new polymeric biomaterials for applied medical uses and the development of new fibrous materials for various healthcare applications. Some recent examples are outlined below.

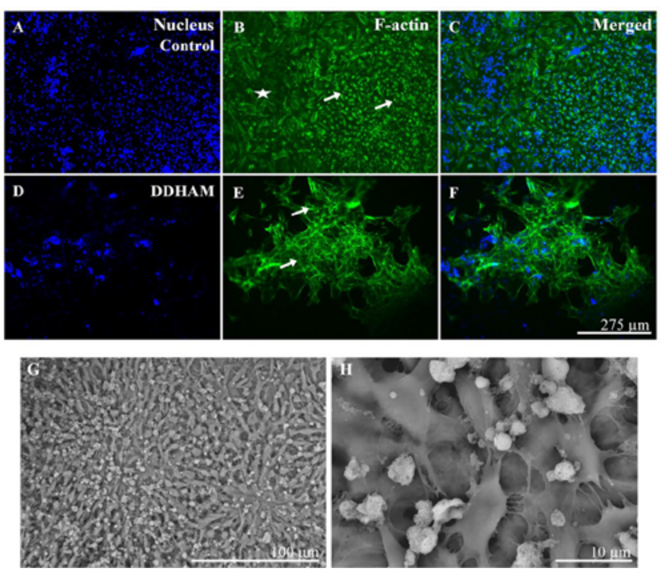
Since the early 2000s, barbed sutures have been a research focus at Wilson College involving King and Gluck. Barbed sutures were first patented in 2005 as a novel method to close surgical sites without the need to tie individual knots. The directionality of a barbed suture allows for a continuous thread in a unique suturing pattern to close a wound more efficiently. The first uses were developed as a "micro-lift" in cosmetic surgery in lieu of a full face lift. Beyond the initial collaboration with Ruff to develop and use barbed sutures for cosmetic surgeries, research has been done to improve the barbing process. New suturing techniques and new barbing techniques have been explored. Current advances are in discussion for further development and licensing.

Polymeric hydrogels form another class of biomedical textiles used for various medical applications. The advantages of hydrogels is the control of the environment — different physical

Biomedical Textiles at NC State

properties can easily be tuned by altering the crosslinking chemistry of the polymers. Additionally, hydrogels provide an aqueous environment advantageous to cell proliferation. Hybrid chitosan-poly(vinyl alcohol) hydrogels were developed based on different molecular weights of chitosan, thereby demonstrating varying final properties of the hydrogels which can be tailored for specific final regenerative medicine applications. Additionally, it was found that different sterilization methods have varying effects on the hydrogel properties and their specific end uses.

The idea of combining fibrous materials with hydrogels is an attractive line inquiry to incorporate the best properties of both materials. Composite structures were created using electrospun polycaprolactone nanofibrous scaffolds and Gelatin-methacrylate (GelMA) hydrogels to increase the mechanical properties of the hydrogel, while also enhancing cell adhesion of the fibrous structures. Additional hybrid hydrogels were developed using traditional fibers to reinforce mechanical properties for cardiovascular applications. These hybrid hydrogels were further demonstrated for use as a vascular graft, which can be used to modulate macrophage polarization.

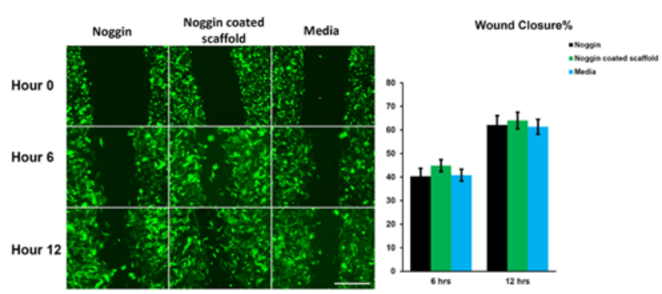


From Mahmood N, et al. Regenerative Engineering and Translational Medicine, 2025 (in press). Pluripotent stem cell-derived limbal stem cells adhere and proliferate on commercially available decellularized and dehydrated human amniotic membrane (DDHAM). A-F) Immunocytochemistry for f-actin (green) to visualize the cytoskeleton of stem cell-derived limbal stem cells on DDHAM (nucleus = blue, scale bar=275µm). G-H) Representative scanning electron microscopy image of cells adhered on DDHAM after seven days of maintenance.

OUTREACH EFFORTS

Significant impacts on developing biomedical textiles for tissue engineering applications have been made, which are accompanied by a commitment to providing opportunities for students to learn about the work in biomedical textiles. The BMT Research Group and Gluck Tissue Engineering Lab both regularly participate in research experiences for undergraduates. These opportunities are available through the Wilson College, the department of Textile Engineering, Chemistry and Science and the Comparative Medicine Institute. Three years ago, the group participated in the SFB Biomaterials Education Challenge by developing a hands-on experience for middle school students to better understand how fibrous scaffolds are made from decellularized material. Under Gluck's supervision, the BMT group also works with the North Carolina School of Science and Mathematics and has hosted high school students to volunteer with the group. Additionally, graduate students from BMT group and Gluck Lab regularly participate in the Summer Textile Exploration Program, which provides a week-long residential camp for rising high school seniors to participate in a hands-on medical textile project.

The Wilson College of Textiles is heavily invested in leading the field across many aspects of medical textiles research including surgical and implantable materials, drug delivery devices, tissue engineering and regenerative medicine and in preparing the next generation of textile scientists. Through its research in the Biomedical Textile Research Group and Gluck Tissue Engineering Lab, NC State's Wilson College is achieving its vision for textiles to enhance quality of life for all by creating advances in medical science and healthcare through material innovation that will lead to better interventions for healthcare providers and improved patient outcomes.



From Mahmood N et al, 2023; Translational Vision Science and Technology, 2023; 12: 15. Electrospun scaffolds were coated with the recombinant protein Noggin and applied to an artificial wound made with GFP-corneal epithelial cells. The "scratch" treated with the Noggin-coated scaffold exhibited higher wound healing and cell migration, indicating a role for Noggin-treated biomaterials in ocular surface wound repair.

Visionary Materials: The Evolution and Impact of Ophthalmic Biomaterials

By Katelyn Swindle-Reilly, The Ohio State University, Past Chair of Ophthalmic Biomaterials SIG

Vision is one of our most vital senses critical for daily function. Vision loss can lead to significant emotional, social, and economic burdens, decreasing independence and quality of life. Within the United States alone, more than 50 million adults report experiencing some amount of difficulty seeing, even when wearing glasses. Of these, more than 300,000 cannot see at all.[1] This issue is further compounded globally. More than 2 billion people have visual impairment, with half of these people experiencing vision impairment that could either have been prevented or has yet to be addressed.[2] Biomaterials researchers can have a significant impact on vision outcomes and quality of life, especially if we work together to think creatively about solutions that can help overcome the global shortage of ophthalmologists and optometrists.

Katelyn Swindle-Reilly with several members from her research group in newly constructed laboratory space in Fontana Labs, which is part of the Biomedical and Materials Engineering Complex at The Ohio State University. From left to right: PhD student Noumi Farnaj, PhD student Victoria Blanc, PI Katelyn Swindle-Reilly, PhD student Meghal Keskar, BS student Poulami Ghosh, PhD student Peter Jansen, Postdoc Ravi Saklani and BS graduate Spencer Green.

The leading causes of vision impairment and blindness are refractive errors, most often treated by glasses or contact lenses, and cataracts, which are treated by removal of the lens tissue and surgical implantation of a synthetic polymeric intraocular lens (IOL). Did you know that cataract extraction is one of the most prevalent surgical procedures performed? It is also one of the earliest implantations of a synthetic polymer, poly(methyl methacrylate) or PMMA. Just over 75 years ago, Sir Harold Ridley performed the first implantation of a PMMA-based IOL to replace a damaged lens in a patient with cataracts. As the story commonly told in biomaterials courses goes, while serving as an ophthalmologist with the Royal Air Force, Ridley observed that pilots with eye injuries caused by shattering cockpit canopies (made of PMMA) did not experience severe inflammatory reactions.[3] While PMMA is still a component of some IOLs, biomaterials advances have significantly improved the design and delivery of these now-foldable IOLs, making cataract extraction a relatively quick outpatient procedure that typically does not require sutures.

A 1950 Ridley intraocular lens — one of the oldest, if not the oldest, IOLs in the world.[3]

Ocular biomaterials have long stood at the intersection of innovation and necessity, driving advances in vision restoration, drug delivery and ocular tissue engineering. Did you know that one of the most common uses of amniotic membrane is for corneal repair? How often do we think of contact lenses as medical devices? The comfort and wearability of modern contact lenses has greatly impacted society. Innovators who developed ophthalmic technologies we now consider commonplace contributed greatly to Society For Biomaterials and have been recognized for their achievements. The inventor of the soft contact lens, Otto Wichterle, was awarded the Clemson Award for Basic Research in 1984. Joseph Salamone was awarded the Clemson Award for Applied Research in 2006 for his many contributions in this field – he developed the gas-permeable contact lens, setting the standard for oxygen-permeable contact lenses.

The table below gives just a snapshot of the impact of biomaterials research from basic to applied to technology development in the field of ophthalmology. This includes development of new biomaterials that are being used in ophthalmic and other applications, developing test methods, evaluating cell-material interactions and developing new biomaterials processing methods to advance drug delivery, to name a few. Some of the awardees have focused their research on ophthalmic biomaterials and started companies to translate to the clinic, while many on the list have either made fundamental biomaterials advances across disciplines or have recognized their potential impact when applied to ophthalmology. Advancing both fundamental and translational research in ocular biomaterials is critical to developing innovative therapies that preserve and restore sight, offering hope to those facing visual impairment.

Visionary Materials: The Evolution and Impact of Ophthalmic Biomaterials

SFB Awardees with Contributions to Ophthalmic Biomaterials

Year	Award	Recipient	Affiliation
2024	Technology Innovation & Development Award	Mark R. Prausnitz	Georgia Institute of Technology
2018	Clemson Award for Applied Research	Mark Grinstaff	Boston University
2017	Technology Innovation & Development Award	Len Pinchuk	Innovia, LLC
2016	Clemson Award for Applied Research	Justin Hanes	Johns Hopkins University
2014	Society For Biomaterials Award for Service	Anne Meyer	University at Buffalo
2012	Clemson Award for Contributions to the Literature	Molly S. Shoichet	University of Toronto
2012	Young Investigator Award	Steven R. Little	University of Pittsburgh
2011	C. William Hall Award	Shalaby Shalaby	Poly-Med, Inc.
2007	Clemson Award for Contributions to the Literature	David L. Kaplan	Tufts University
2006	Clemson Award for Applied Research	Joseph Salamone	Bausch + Lomb
2006	Technology Innovation & Development Award	Shalaby Shalaby	Poly-Med, Inc.
2003	Technology Innovation & Development Award	Robert S. Ward	The Polymer Technology Group
2002	C. William Hall Award	Anne Meyer	University at Buffalo
2000	Clemson Award for Applied Research	M. F. Refojo	Schepens Eye Research Institute, Harvard Medical School
1998	Clemson Award for Applied Research	Eugene P. Goldberg	University of Florida
1984	Clemson Award for Basic Research	O. Wichterle	Institute of Macromolecular Chemistry, Prague

ADVANCING INNOVATION IN BIOMATERIALS AT OHIO STATE

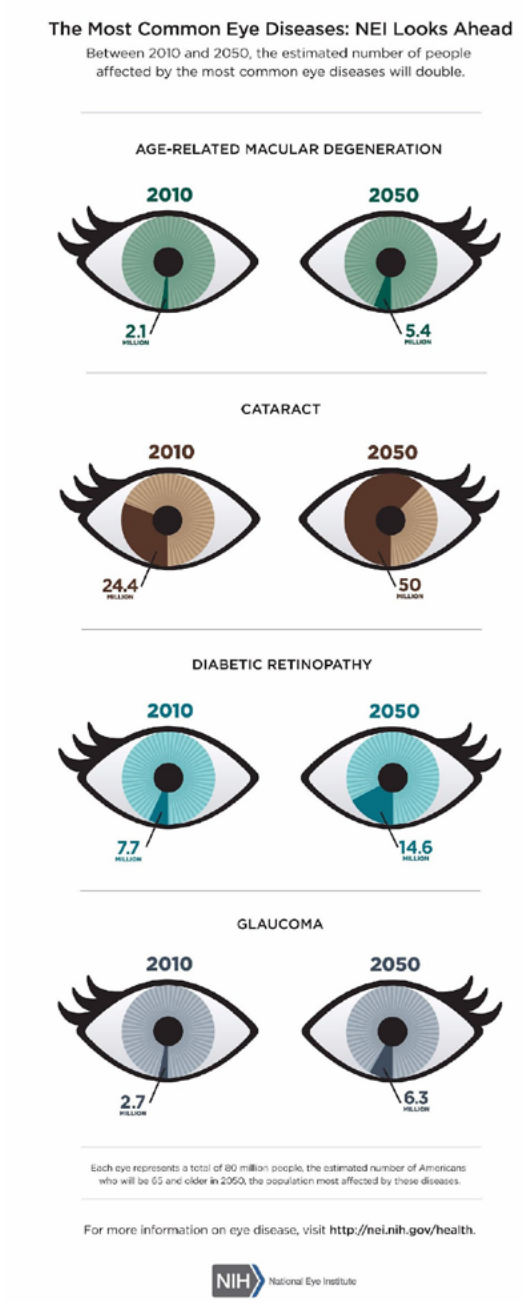
The Ohio State University is leading biomaterials research programs from basic science to clinical translation. Ohio State's interdisciplinary approach — bridging sciences, engineering disciplines, dentistry, nursing, optometry, pharmacy, medicine and veterinary medicine — has enabled breakthroughs in natural materials, responsive materials and biosensors, medical devices, regenerative therapies and controlled drug delivery.

Within the College of Engineering alone, there are research strengths spanning biopolymers, polymer science, nanomaterials, materials characterization and processing, biosensors, tissue engineering, therapeutic delivery and translational medicine. These collaborative biomaterials research programs and educational opportunities are housed in Biomedical Engineering; Chemical and Biomolecular Engineering; Electrical and Computer Engineering; Food, Agricultural and Biological Engineering; and Mechanical and Aerospace Engineering.

The university's state-of-the-art facilities in the Advanced Materials Corridor include the Biomedical and Materials Engineering Complex which currently houses both the Department of Biomedical Engineering and Department of Materials Science and Engineering. Phase 2 will be completed by next year, and will be the home of first-year engineering courses, makerspace and

Visionary Materials: The Evolution and Impact of Ophthalmic Biomaterials

K-12 STEM programs in addition to biomedical and advanced materials research and development. Ohio State is also home to centers and institutes that spur translational biomaterials research including the Institute for Materials and Manufacturing Research and the Medical Modeling, Materials and Manufacturing (M4) Division housed within the Center for Design and Manufacturing Excellence.



In 2010, age-related macular degeneration, cataract, diabetic retinopathy, and glaucoma impacted 36.9 million Americans. The number impacted is expected to more than double by the year 2050.[4]

ADVANCING OCULAR BIOMATERIALS AT OHIO STATE

Ocular biomaterials research at Ohio State is being conducted on the front to the back of the eye – the cornea to the optic nerve. Past chair of the Ophthalmic Biomaterials SIG Katelyn Swindle-Reilly runs a lab at Ohio State that focuses on ocular biomaterials and drug delivery systems. Research progress and innovation is greatly enhanced by having four faculty members within Biomedical Engineering alone that focus on ocular engineering. Collaborations with Ophthalmology and Neuroscience within the College of Medicine as well as with top vision researchers at the Ohio State College of Optometry further support cutting-edge research in biomaterials design and characterization and enhance the translational potential of Ohio State's innovations.

These clinical collaborations and insights from ocular biomechanics and imaging have enabled the breadth of ocular biomaterials research, with a focus on preventing and treating degeneration and fibrosis associated with aging, injury and disease. With collaborators in Engineering, Optometry and Medicine, they have recently published articles using thermo-responsive hydrogels and bioprinting techniques to prevent corneal fibrosis with the goal of reducing the need for human corneal transplants. A recent publication used polymers to elucidate the impact of cell-material interactions on lens epithelial cells to prevent fibrosis and complications after cataract surgery. Ongoing studies are focusing on micropatterning and the effects of surface topography. Most of the lab's ongoing and published research has focused on the vitreous humor and drug delivery to the retina and optic nerve. The Swindle-Reilly lab is exploring loading therapeutics into hydrogel vitreous substitutes to prevent complications after vitrectomy surgery. Most of the projects focus on intravitreal and retrobulbar sustained-release systems to deliver current and novel therapeutics to the retina and optic nerve, with a focus on retinal degenerations caused by age-related macular degeneration and optic neuropathy. Support from the DOD and NIH are enabling preclinical studies of these new delivery systems and therapeutics.

A LEGACY OF LEADERSHIP AND INNOVATION

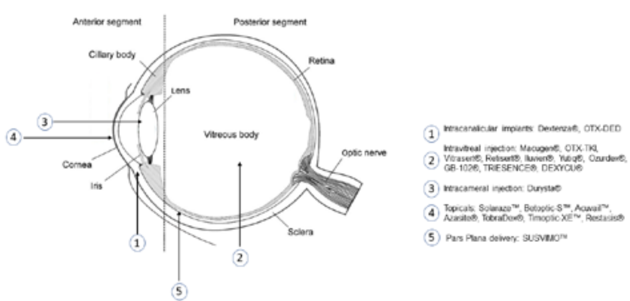
Ocular biomaterials have long stood at the intersection of innovation and necessity, driving advances in vision restoration, drug delivery and ocular tissue engineering. Since the formation of the Ophthalmology Special Interest Group (SIG) in 1993 – one of the original 10 SIGs within the Society For Biomaterials — the field has grown in both complexity and impact. The SIG, now known as the Ophthalmic Biomaterials SIG, has served as a hub for researchers and clinicians dedicated to improving eye health through materials science and engineering.

The inaugural chair of the Ophthalmic Biomaterials SIG, George

Visionary Materials: The Evolution and Impact of Ophthalmic Biomaterials

Grobe, at that time employed by Bausch + Lomb, laid the foundation for a community focused on translational research and interdisciplinary collaboration. Subsequent chairs have continued this legacy, with representation over the years from both academia and industry. Aliasger Salem, Lyle and Sharon Bighley Endowed Chair and Professor and Associate Vice President for Research at the University of Iowa, will continue the mission to bridge the gap between "research" and "development" of applied biomaterials in ophthalmology.

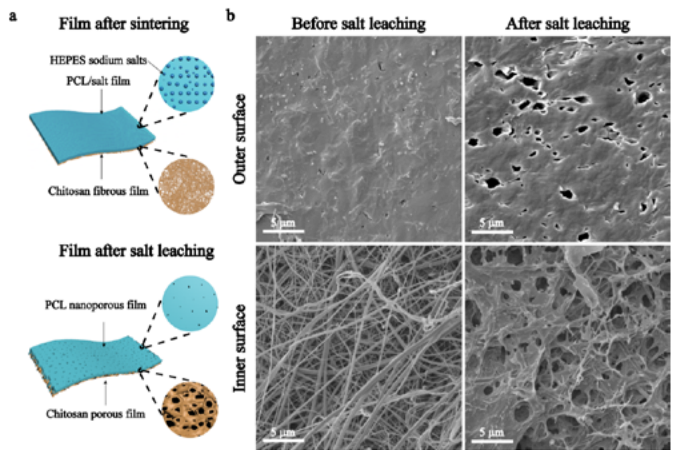
- George Grobe (1993-1995)
- Robert Scott (2001–2003)
- Pericles Calias (2003–2005)
- Margaret Kayo (2005–2007)
- Jean Jacob (2007–2009)
- Jinyu Huang (2009–2011)
- Andy Doraiswamy, PhD (2011–2013)
- Rakhi Jain (2013–2015)
- Yasushi Kato (2015–2017)
- Morgan DiLeo (2017–2021)
- Katelyn Swindle-Reilly (2021–2025)
- Aliasger Salem (2025–present)



Schematic of the eye. Light passes through the cornea which does initial refraction, then through the lens which does fine focusing, and through the vitreous body to the retina. Cells in the retina convert light into electrical signals, triggering a chemical and electrical response which is passed through the optic nerve to carry visual information to the brain. Several common ocular drug delivery routes are shown with associated implants. Suprachoroidal delivery was enabled by Clearside Biomedical's microneedle technology, and subretinal delivery is being used for gene therapy.[5]

HONORING OUR LEGACY

As we celebrate the ongoing innovations in ocular biomaterials, we also recognize the individuals associated with Society For Biomaterials whose contributions have truly shaped the field, enhancing visual outcomes for millions of people worldwide. Over the years, the Society has proudly honored several researchers from academia and industry with major awards for their outstanding work and contributions that contributed to or focused on ophthalmic biomaterials. These awardees have advanced our understanding and development of contact lenses, implantable devices including intraocular lenses, ocular drug delivery systems and regenerative therapies, and their work continues to inspire the next generation of scientists. The Ophthalmic SIG welcomes your interest and involvement in our programming.



Collaborative biomaterials research led by Pengfei Jiang, a PhD graduate from the Swindle-Reilly lab at Ohio State, resulted in a tunable, injectable, biodegradable polymeric implant with potential to release therapeutics including antibodies for 9-12 months. a) The fabrication process combines electrospinner, sintering, and salt leaching. b) Scanning electron micrograph image of bi-layered structure before and after salt leaching. This technology has been licensed to translate to the clinic.[6]

ACKNOWLEDGEMENTS AND CONTRIBUTIONS

Many thanks to Dan Lemyre and Alan Litsky for providing some of the historical information. Any omissions were unintentional. To ensure our historical records are complete, we are seeking information on SIG Chairs who served between 1995 and 2001. If you have documentation, personal recollections, or archival materials from this period — or if you know of additional awardees who worked on ocular biomaterials — please contact the SIG leadership or the Society For Biomaterials office. Your contributions will help preserve the rich legacy of the Ophthalmic Biomaterials SIG and ensure that the achievements of our community are fully documented and celebrated.

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Combinatorial and Bio-Inspired Strategy for Mitigating Medical Device-Associated Infections and Thrombosis

By Dr. Arpita Shome and Prof. Hitesh Handa

Hospital-acquired infections (HAIs) are an escalating concern, contributing towards prolonged hospitalization, increased medical costs, risk of amputation and even patient morbidity.[1] The primary factors for HAIs across the globe are thrombosis and bacterial infections of blood-contacting medical devices such as catheters, stents, grafts, implantable devices and ECC technologies.[2] Thrombosis or blood clot formation causes blood vessel obstruction, resulting in stent blockage, occlusion of catheters and vascular grafts, errant results from implantable sensors, embolic complications with artificial hearts, or extensive blood damage and platelet consumption during extracorporeal membrane oxygenation. Heparin is the standard anticoagulation therapy in clinical settings, however heparin-induced thrombocytopenia is a well-established challenge. Concurrently, the free-floating bacteria from the surroundings can adhere to the surface of any medical device and trigger the formation of microbial microcolonies, producing the extracellular polymeric substances that eventually induce the unwanted biofilm formation on the surface. The conventional approaches to managing medical device-associated bacterial infections include antibiotic administration pre- and post-surgical procedure, removal of the infected devices and following hygienic practices. The rise of antibiotic resistance undermines conventional treatment strategies, while the removal of medical devices can be traumatic to the patient's well-being.

As the biomedical industry continues to engineer innovative designs to mitigate the thrombosis and infection issues, bio-inspired antifouling surfaces are quietly emerging as clinically and economically effective solutions. The "accidental" slipping of insects into the pitcher of the Nepenthes Pitcher plant is a classic interplay of surface chemistry and morphology in nature.[3] The hierarchical textured rim of the pitcher facilitates retaining the nectar secreted by the plant or the rainwater. Subsequently, this trapped aqueous phase acts as an immiscible lubricant for the beaded oily-legged insect, thereby directing the "accidental" slipping and stimulating the design of numerous bio-inspired lubricant-infused slippery surfaces to combat biofouling. Solid slippery surfaces have emerged as a promising alternative to eliminate the need for an infused synthetic lubricant that is at risk of volatilization or depletion under continuous shear.[4] Solid slippery surfaces comprise of alkylated/fluorinated small molecules or polymers that are covalently bound to the underlying surface. The free rotation of the alkylated/fluorinated solid side chains imparts the "liquid-like" lubricating property to repel the beaded biofoulants from the surface. Our group recently utilized amine-epoxy chemistry to develop hemocompatible, solid slippery coatings on polymers, metals and glass that effectively resisted the growth of biofilms, fibrinogen and platelet adhesion — outlining potential in blood-contacting medical devices.[5] But the challenge of suppressing platelet activation and eradicating planktonic bacteria remains unresolved solely using passive anti-adhesive surfaces.

The strategic combination of passive antifouling surfaces with bioactivity considers the advantages of both approaches while overcoming the individual limitations.[6] Drawing from extensive literature and realizing the shortcomings of the commercialized designs, our group integrated novel solid slippery coatings with nitric oxide chemistry. In the 1980s, nitric oxide (NO) was discovered as an endogenously produced free-radical gasotransmitter responsible for regulating vascular hemostasis and immunological and neuronal responses.[7-8] NO, a potent vasodilator secreted by the normal endothelium, can inhibit platelet activation and aggregation near the blood vessel wall, preventing thrombosis in normally circulating blood. NO produced by nasal epithelial cells and macrophages is also known to be antimicrobial and antifungal.[9] As a proof-of-

Combinatorial and Bio-Inspired Strategy for Mitigating Medical Device-Associated Infections and Thrombosis

concept demonstration, we incorporated medical-grade polymers such as silicone, polyvinyl chloride and polyurethane with an NO-releasing organic molecule to constitute the bioactive polymer, followed by application of the solid slippery formulation as the passive surface modification strategy.[10] The presence of heat, light or physiological conditions triggers NO release from the donor molecule present in the polymer, without interference from the solid slippery coating. The gaseous nature of NO enables biofilm permeability and planktonic bacterial killing, while the solid slippery coating limits bacterial adhesion and biofilm growth. We have reported a significant reduction in human fibrinogen adhesion as well as platelet activation and aggregation. Interestingly, the synergistic effect of the combinatorial strategy resulted in markedly enhanced fouling resistance relative to the standalone bioactive or passive surface modifications.

In the dynamically evolving field of medical devices, integrating bio-inspired passive surface modifications, particularly those leveraging solid slippery coatings with nitric oxide chemistries, holds significant promise for enhancing device performance. With the promising in vitro results, the ongoing in vivo evaluation of these combinatorial approaches aims to truly understand the translational ability to foster far-reaching clinical, economic, societal and technological outcomes.

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Tools and Strategies for Meaningful and Measurable Research Impact

By Janice D. McDonnell and Susan D. Renoe

In today's complex and interconnected world, the societal relevance of scientific research has never been more critical. As funding agencies, institutions and communities increasingly call for science that not only advances knowledge but also benefits society, researchers are seeking effective ways to design, implement and evaluate the broader impacts of their work. The U.S. National Science Foundation (NSF) has long championed this vision through its Broader Impacts (BI) criterion, and the NSF-funded Center for Advancing Research Impacts in Society (ARIS) is leading the charge in helping researchers meet this challenge.

THE EVOLVING LANDSCAPE OF RESEARCH IMPACTS

The concept of broader impacts is not new, but its implementation has evolved significantly. Initially seen as an add-on to research proposals, broader impacts are now recognized as integral to the research process. They encompass a wide range of activities — from engaging K-12 students and partnering with community organizations to enhancing workforce skills in STEM.

However, many researchers still struggle with how to conceptualize and articulate these impacts in meaningful and measurable ways. Today, there are many resources available for researchers to address this problem. Institutions have invested in BI infrastructure — either in the form of offices dedicated to societal impact or as part of existing personnel duties. A BI professional "bridges the gap between scientific research and its potential benefits to society" and can be found in "academic, non-profit, government, private sector or community-based" organizations (Iverson et al., 2024). Often, they are available to help researchers plan, implement and evaluate their impact plans.

A good first step to creating meaningful broader impacts is to look for a BI professional on your campus. They might "be found in museums, STEM Engagement Centers, Extension offices and many other places on campus and off" (Renoe, 2025) as well as in research development and community engagement offices. Although their job title might not identify them "as BI professionals, they work to ensure that scientific research serves the public good in a variety of ways, including but not limited to fostering public engagement, enhancing education…and contributing to economic development." (Iverson et al., 2024).

In addition to institutional capacity for BI, researchers can also look to ARIS for resources and support.

ARIS: A NATIONAL HUB FOR RESEARCH IMPACT

Founded in 2018 and headquartered at the University of Missouri, ARIS supports the development of high-quality broader impacts plans, and fosters a culture of engagement across the research enterprise. ARIS provides training, resources and a vibrant community of practice for researchers, administrators and BI professionals.

At the heart of ARIS's mission is the belief that research should serve society. To that end, ARIS works to build capacity for public engagement and supports institutional change. Its work is grounded in evidence-based practices and informed by an expansive network of members representing universities, federal agencies, nonprofits and community partners.

THE ARIS TOOLKIT: A PRACTICAL GUIDE FOR RESEARCHERS

One of ARIS's most impactful contributions is the **ARIS Broader Impacts Toolkit** — a suite of resources designed to help researchers develop, assess and refine their broader impacts plans. The toolkit includes the **BI Wizard**, a **Planning Checklist, A Project Rubric** and the updated version of the ARIS **Guiding Principles (see Table 1).**

Table 1. ARIS Toolkit Resources Across Proposal Stages*

	Introduction to BI & Initial Planning Stage	Proposal Development	Pre-Submission Review	Panel Review
Guiding Principles 2.0 A foundational document that outlines key values and strategies for impactful engagement.				
Planning Checklist A quick reference to ensure all critical elements of a BI plan are addressed.				
BI Wizard An interactive tool that guides users through a step-by-step process to create a BI plan.				
BI Rubric A framework for evaluating the quality and feasibility of proposed BI plans.				

*Adapted from Hotaling et al., 2024.

These tools are freely available on the ARIS website (researchinsociety.org) and are applicable to both early-career and seasoned researchers across all disciplines.

BUILDING A CULTURE OF IMPACT

Beyond individual tools, ARIS is helping to shift the culture of research toward one that values and rewards societal engagement. Through its fellowship programs, institutional partnerships and national forums, ARIS is cultivating a new generation of scholars who are as committed to public good as they are to scientific excellence.

Recent initiatives include the **Program to Enhance Organizational Research Impact Capacity**, which helps institutions embed impact practices into their research infrastructure, and the **ARIS Fellows Program**, which supports leaders in advancing impact scholarship and practice.

LOOKING AHEAD

As the scientific community grapples with global challenges, the need for research that is both rigorous and relevant has never been greater. ARIS and its resources offer a roadmap for researchers who want to make a difference beyond the lab.

By embracing the tools and principles of broader impacts, scientists can forge deeper connections with society and enhance the value of their work.

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Member News

By Guillermo Antonio Ameer, ScD

Nicholas Peppas, ScD.

Nicholas Peppas, ScD., Professor, McKetta Department of Chemical Engineering, Department of Biomedical Engineering, Department of Pediatrics, Department of Surgery and Perioperative Care, and Division of Molecular Pharmaceutics and Drug Delivery, University of Texas at Austin

Nicholas Peppas, the Cockrell Family Regents Chair in Engineering and professor at the University of Texas at Austin, will receive the American Institute of Chemical Engineers Cato T. Laurencin Regenerative Engineering Society Founder's Award for 2025 https://chenected.aiche.org/2025/08/cato-t-laurencin-regenerative-engineering-founders-award-american-institute.

Peppas is slated to receive the prize on Monday, Nov. 3, at the 2025 AIChE Annual Meeting in Boston, MA, at the Regenerative Engineering session. He will give the keynote lecture: "The Future of Regenerative Engineering and Bionanotechnology." First presented in 2023, the award honors the founder and pioneer of the field of regenerative engineering, Professor Sir Cato T. Laurencin, M.D., Ph.D., K.C.S.L., and recognizes individuals for leadership in the science and practice of convergence research as applied to regenerative engineering and medicine.

Peppas was also honored with an Honorary Doctor of Entrepreneurship degree from Rowan University. This recognition was part of Rowan's 2025 commencement ceremony, where Peppas also delivered a commencement speech. Additionally, an award for excellence in doctoral studies, the Nicholas A. Peppas Sc.D. Medallion, is named in his honor at Rowan's Henry M. Rowan College of Engineering.

Guillermo Ameer, Sc.D., Professor, Department of Biomedical Engineering, Department of Surgery, Northwestern University

Guillermo Ameer, the Daniel Hale Williams Professor of Biomedical Engineering and Professor of Surgery, will be the plenary speaker at the 20th National Congress of Science and Technology sponsored by the Panamanian Association for the Advancement of Science (APANAC), to be held in Panama City, Republic of Panama, Sept. 29 to Oct. 3, 2025. Ameer, the director of the Querrey Simpson Institute for Regenerative Engineering at Northwestern University (QSI RENU), will speak on the role of biomaterials in regenerative engineering and medicine. Ameer is a leader in regenerative engineering, biomaterials, additive manufacturing for biomedical devices, controlled drug delivery and bio/nanotechnology for therapeutics.

Ameer was also a co-organizer of the annual Rockstars of Regenerative Engineering symposium held at the American Chemical Society's fall meeting in Washington D.C., on August 19, 2025 (https://renu.northwestern.edu/news-events/news/ameer-wang-featured-at-rock-stars-of-regenerative-engineering-event.html). QSI-RENU was a co-sponsor of the event. Symposium co-organizers included Melissa Grunlan (Texas A&M), Paulos Mengsteab (The Ohio State University) and Whitney Stoppel (The University of Florida). The 2025 Rockstars of Regenerative Engineering were Eben Alsberg (University of Illinois Chicago), Manu Platt (National Institutes of Health), Elizabeth Cosgriff-Hernandez (University of Texas at Austin), Gulden Camci-Unal (U Mass. Lowell) and Warren Grayson (Johns Hopkins).

Member News

Recent Publications from Ameer:

1. Microtopography-induced changes in cell nucleus morphology enhance bone regeneration by modulating the cellular secretome. Wang X., Yiming L., Lin Z., Pla I., Gajjela R., Mattamana BB., Joshi M., Liu Y., Wang H., Zun AB., Wang H., Wai CM., Agrawal V., Dunton CL., Duan C., Jiang B., Backman V., He TC., Reid R.R., Luo Y., and Ameer G.A. **Nature Communciations**, https://doi.org/10.1038/s41467-025-60760-y, 2025

2. Panthenol Citrate: A Photoprotective Antioxidative Molecule for Shielding Skin against UV Radiation. H. Wang, R. Luo, O. Tong, Y.H. Chin, B. Perez-White, G.A. Ameer. **ACS Applied Materials and Interfaces.** https://doi.org/10.1021/acsami.5c05441, 2025

3. Evaluation of an antioxidative thermoresponsive polydiolcitrate hydrogel in a novel diabetic pig impaired wound healing model. M. Mendez-Santos, Y. Zhu, M. Alloosh, C. Duan, M. van den Berg, M. Sturek, and G.A. Ameer, **Regenerative Engineering and Translational Medicine**, https://doi.org/10.1007/s40883-025-00425-w, 2025.

Binata Joddar, Associate Professor, Chemical, Biological and Environmental Engineering, Oregon State University.

Binata Joddar published a game-changing paper on the utilization of microfluidic chips to assess and monitor the behavior of human central nervous system neurons during a suborbital flight. https://www.jotform.com/uploads/SFB2020/251495136276058/6294495831634662672/s41526-025-00476-x%20%282%29.pdf

Emily Day, PhD, Professor, Department of Biomedical Engineering, University of Delaware.

Emily Day has been promoted to Professor of Biomedical Engineering at the University of Delaware. Day was a founding hire in the department in 2013, so this achievement represents both a personal and departmental milestone

Aliasger Salem, Ph.D., Professor, College of Pharmacy, University of Iowa

Aliasger Salem, the Lyle and Sharon Bighley Endowed Chair and Professor of Pharmaceutical Sciences, will take on the following leadership roles within the Society for Biomaterials:

Chair, Ophthalmic Biomaterials SIG.
Program Chair, Drug Delivery SIG.
Treasurer/Secretary, Immune Engineering SIG.

For the Immune Engineering SIG, Salem will be working together with Joshua C. Doloff, Abhinav (Abhi) Acharya and Michelle Teplensky. For the Drug Delivery SIG, Salem will be

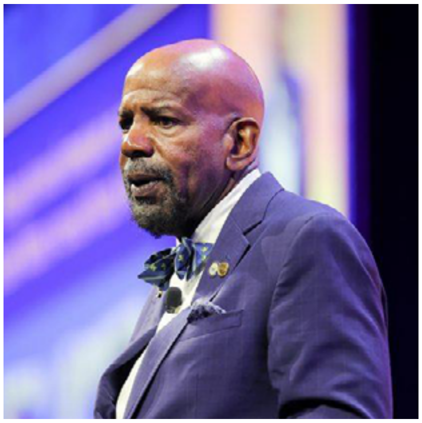
Member News

working together with John Clegg, John Martin and Dhanashree Surve. For the Ophthalmic Biomaterials SIG, Salem will be working together with Muhammad Rizwan and Jessica M. Gluck. The teams are looking forward to having an impact on these disciplines.

Recent publications from Salem:

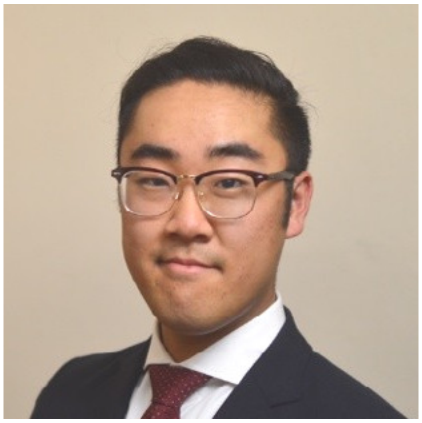
1. Systematic Review of Extracellular Vesicle-Derived microRNAs Involved in Organ Fibrosis: Implications for Arthrofibrosis Therapy. V. Ganesh, R. He, J.A. Martin, A.K. Salem, E.A. Sander, K. Shin, D. Seol. Journal of Translational Medicine. 2025.

2. Extracellular Vesicle-Based Cell Homing and Odontogenic Differentiation for Dentin Regeneration and Their Profiles of microRNAs. V. Ganesh, D.C. Fredericks, E.B. Petersen, H.L. Keen, R. He, J.D. Turner, J.A. Martin, A.K. Salem, K. Shin, A. Parolia, D. Seol. International Journal of Molecular Sciences. 2025.



Sir Cato T. Laurencin, University Professor and Albert and Wilda Van Dusen Distinguished Endowed Professor of Orthopaedic Surgery at UConn School of Medicine, professor of Chemical Engineering, professor of Materials Science and Engineering and professor of Biomedical Engineering at the University of Connecticut.

Sir Cato T. Laurencin delivered the Fred Kavli Innovations in Chemistry Keynote Lecturer at the American Chemical Society (ACS) Fall 2025 conference in Washington, D.C. The Innovations Lecture highlights scientists who demonstrate out-of-the-box thinking. Laurencin's lecture, "Regenerative Engineering: Breakthroughs in Science" was part of the Kavli Foundation Lecture Series. The series recognizes groundbreaking discoveries by scientists tackling global challenges. (https://today.uconn.edu/2025/08/uconn-professor-sir-cato-t-laurencin-delivers-keynote-address-at-american-chemical-society-fall-2025-meeting/)



Samuel Sung, PhD Candidate in Biomedical Engineering, Drexel University

Samuel Sung was awarded a Fulbright Grant to do research in Germany. He will be investigating the immunomodulatory effects of gelatin methacryloyl (GelMA) on iPSC-derived macrophages (iMACs). He will explore how biomaterials affect or influence the phenotype of macrophages sourced from induced pluripotent stem cells (iPSC) at the Medizinishce Hochschule Hannover under the guidance of Dr. Nico Lachmann and his team.

Industry News

MARKET OUTLOOK AND GROWTH TRENDS

- The **U.S. biomaterials market** was valued at approximately **$23.45 billion** in 2024 and is expected to grow to about **$35.67 billion by 2030**, reflecting a CAGR of around **7.2 percent**. Growth is being driven by regenerative medicine, orthopedic applications and advances in 3D printing and smart biomaterials.[1]
- On a global scale, the biomaterials market is projected to expand from **$171.35 billion in 2024** to **$523.75 billion by 2034**, with the U.S. — accounting for about **$46.85 billion** in 2024 — experiencing a projected growth to **$144.21 billion by 2034** (CAGR of about 12 percent). The market benefits from strong R&D efforts, the rise of cosmetic surgeries and burgeoning demand in orthopedics and aesthetics.[2]

RESEARCH AND INNOVATION ADVANCES

- **Alginate-based hydrogels** have been developed with markedly improved biocompatibility and controlled-release properties, making them promising candidates for drug delivery systems and tissue-engineering scaffold.[3]
- Progress in **4D fabrication** — shape-changing soft materials like shape-memory polymers and hydrogels — holds transformative potential for dynamic tissue engineering constructs that respond to environmental stimuli.[4]
- **Plasma treatment of polymeric biomaterials** has shown to significantly enhance cell adhesion and interface behavior, benefiting applications such as scaffolds, implants and vascular prostheses in regenerative medicine.[5]

START-UPS SECURING FUNDING

- **Uncaged Innovations** has filed with the U.S. SEC to raise approximately **$7.73 million** in new equity funding. The company develops next-generation biomaterials designed to replace bovine and exotic leathers, combining sustainability with high-performance applications.[6]
- **Dimension Inx**, a biomaterials platform that creates therapeutic materials designed to restore tissue and organ function, is seeking to raise **$15 million** via an SEC-exempt offering to fuel expansion and speed up product development.[7]
- **Carbonwave** (C-Combinator) filed to raise **$7 million** in equity funding. This company focuses on ultra-regenerative, plant-based biomaterials from Sargassum seaweed — targeting applications such as vegan leather alternatives and cosmetic emulsifiers, all sourced sustainably from ocean-derived biomass.[8]

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2. https://www.precedenceresearch.com/biomaterials-market
3. https://time.news/development-and-characterization-of-innovative-alginate-based-hydrogels/
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CALLING ALL BOOKWORMS!

If you'd like to contribute a review of your recent favorite read to the ***Biomaterials Forum***, send it for consideration to the Editor at ***Roger_narayan@ncsu.edu***. If it's approved, it will be published in a future Forum Book Review column!

Government News

NIH STRENGTHENS OVERSIGHT OF FOREIGN RESEARCH COLLABORATIONS

The National Institutes of Health (NIH) has announced a new policy to enhance oversight of foreign research collaborations, requiring that such partnerships be scientifically justified, transparent in their funding and demonstrably beneficial to U.S. health. Under the new approach, NIH will no longer allow foreign subawards to be embedded under domestic parent grants. Instead, foreign partners must be supported through separately tracked NIH subprojects or supplements to improve accountability and safeguard federal investments. For more information, see the Aug. 25 statement by NIH Director Jay Bhattacharya and the related NIH notices on this topic.

NIH TO STREAMLINE FUNDING ANNOUNCEMENTS IN FY2026

On Aug. 14, 2025, NIH announced that, beginning in fiscal year 2026, the agency will no longer post Notices of Funding Opportunities (NOFOs) in the *NIH Guide for Grants and Contracts*. Instead, Grants.gov will serve as the single official source for all NIH grant and cooperative agreement opportunities. The *NIH Guide* will continue to be used for policy and informational notices.

According to NIH, this change is part of their broader effort to simplify the application process and reduce duplication across federal systems. Researchers should note that NOFOs will no longer appear in the weekly *NIH Guide* email updates; instead, investigators can sign up for Grants.gov subscription services to receive alerts about new funding opportunities.

NIH RESTRICTS AI USE AND CAPS APPLICATIONS PER INVESTIGATOR

On July 17, 2025, NIH issued new guidance raising concerns in the research community about the use of artificial intelligence in grant submissions and the number of applications investigators can submit each year.

Under the policy, NIH will not accept applications that are substantially developed by AI, warning of risks such as plagiarism and fabricated citations. Enforcement actions could include referral to the Office of Research Integrity or termination of awards.

NIH is also imposing a new cap on applications. NIH will not accept more than **six applications per Principal Investigator per calendar year** (excluding training and conference grants) **effective Sept. 25, 2025, and beyond**. While NIH notes that only a small number of investigators will be directly affected, the cap limits flexibility for applicants and raises questions about how the policy will impact innovation and access to funding opportunities.

WHITE HOUSE ISSUES EXECUTIVE ORDER ON FEDERAL GRANT OVERSIGHT

On Aug. 7, 2025, President Trump signed an Executive Order aimed at tightening federal grantmaking practices and increasing political oversight of discretionary awards. The order directs agencies to designate senior appointees to review new funding opportunity announcements and discretionary grants to ensure alignment with "agency priorities and the national interest."

Key provisions include:

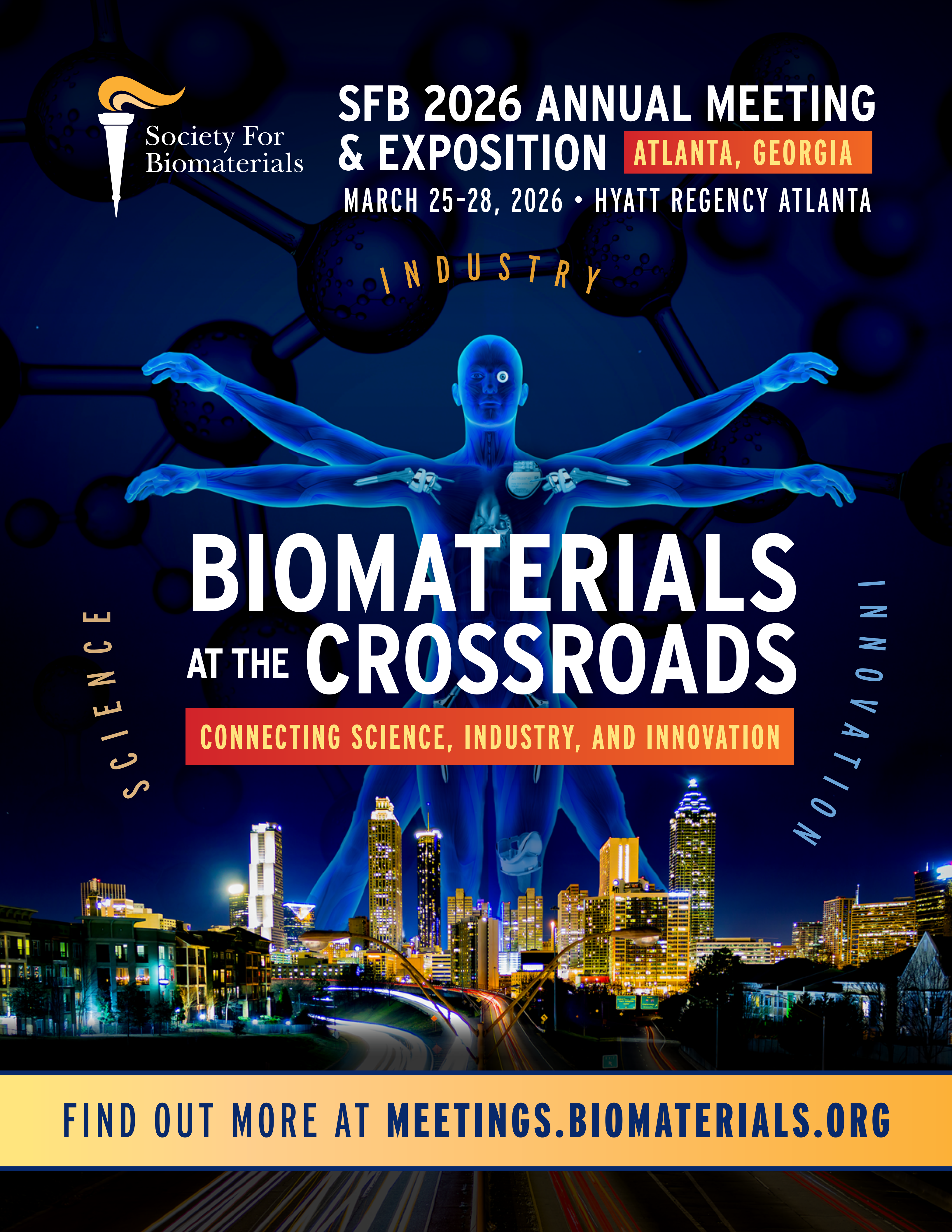
Increased review and oversight: New grants and funding announcements must undergo approval by senior political appointees, with added interagency coordination to reduce duplication.

Restrictions on content: Grants may not fund activities deemed inconsistent with administration priorities, such as projects related to diversity, equity and inclusion; gender identity; or immigration services.

Greater federal control: Agencies are instructed to include "termination for convenience" clauses in discretionary grants, allowing awards to be ended if they no longer advance agency goals.

Shift in funding priorities: Agencies are encouraged to favor institutions with lower overhead rates and to emphasize "Gold-Standard Science" and reproducibility over historical institutional prestige.

The order applies government-wide and is expected to influence how agencies structure grant opportunities and manage awards going forward.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