REMEMBERING JOE SALAMONE

UPDATE FROM THE TE SIG AND BE SIG

BIOMATERIALS FORUM

OFFICIAL NEWSLETTER OF THE SOCIETY FOR BIOMATERIALS

THIRD QUARTER 2019 • VOLUME 41, ISSUE 3

ALSO INSIDE

AN INTERVIEW WITH STEPHANIE SEIDLITS

REFLECTIONS FROM THE CATO LAURENCIN FELLOWSHIP WINNERS

Biomaterials Forum, the official news magazine of the Society For Biomaterials, is published quarterly to serve the biomaterials community. Society members receive *Biomaterials Forum* as a benefit of membership. Non-members may subscribe to the magazine at the annual rate of $48. For subscription information or membership inquiries, contact the Membership Department at the Society office (email: info@biomaterials.org) or visit the Society's website, biomaterials.org.

It is the policy of the Society For Biomaterials that all articles reflect only the views of the authors. Publication of articles or advertisements within *Biomaterials Forum* does not constitute endorsement by the Society or its agents of products, services or views expressed herein. No representation is made to the accuracy hereof, and the publication is printed subject to errors and omissions. Articles that do not have an author byline may originate from press releases. The Society For Biomaterials retains press releases on file for a period of one year from the date of publication.

Editorial contributions to *Biomaterials Forum* are always welcome. Contributions should be sent to the executive editor and are subject to the terms and conditions of the Editorial and Publication Release. Authors should refer to the Author Guidelines, which are available on the Society's website, when writing submissions. The publisher accepts no responsibility for return or safety of artwork, photographs or manuscripts. Submission of editorial content does not guarantee acceptance or publication.

Address corrections should be sent to *Biomaterials Forum*, 1120 Route 73, Suite 200, Mt. Laurel, NJ 08054.

Requests for advertising information should be directed to Amy Chezem at achezem@ahint.com or 856-439-0500. Information is also available on the Society's website, biomaterials.org.

Unauthorized reproduction of this magazine in whole or in part is prohibited without the permission of the publisher. Requests for permission should be directed to the managing editor.

Scientific photos may be submitted for cover consideration in future issues. Submit color photo, no larger than 4" x 6", along with credit information and scientific description, to the executive editor.

Copyright© 2019 • ISSN 1527-6031
Society For Biomaterials
All rights reserved

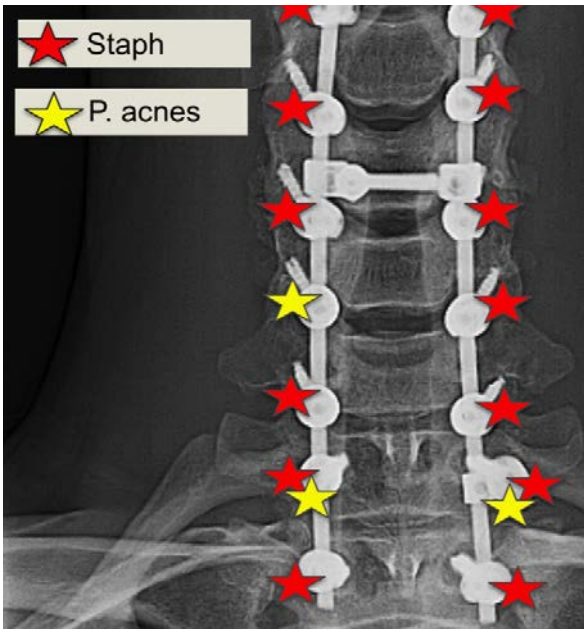
BIOMATERIALS FORUM

The official news magazine of the **SOCIETY FOR BIOMATERIALS** • Volume 41, Issue 3

Executive Editor	Guigen Zhang, University of Kentucky Phone: 859 323-7217 • Fax: 859 257-1856 guigen.bme@uky.edu
Managing Editor	Amy Chezem, Society For Biomaterials 1120 Route 73, Suite 200, Mt. Laurel, NJ 08054 Phone: 856-439-0500 • Fax: 856-439-0525 Email: achezem@ahredchair.com
Government News Contributing Editor	Carl G. Simon Jr., NIST Biosystems & Biomaterials Division Email: carl.simon@nist.gov
News Contributing Editor	Steve T. Lin, Exactech Inc. Email: steve@exac.com
Society Business & Membership News Contributing Editor	Cherie Stabler, University of Florida Email: cstabler@bme.ufl.edu
Special Interest Group News Contributing Editor	Danielle Benoit, University of Rochester danielle.benoit@rochester.edu
Book Review Editor	Lynne Jones, Johns Hopkins University Department of Orthopaedic Surgery Email: ljones3@jhmi.edu
AIMBE News Contributing Editor	Lynne Jones, Johns Hopkins University Department of Orthopaedic Surgery Email: ljones3@jhmi.edu
Education News Contributing Editor	C. LaShan Simpson, Ph.D., Mississippi State University Agricultural and Biological Engineering clsimpson@abe.msstate.edu
Historical Flashback Editor	Guigen Zhang, University of Kentucky Email: guigen.bme@uky.edu
Student News Contributing Editor	Jason Guo, Rice University Email: JLG19@rice.edu

SPECIAL INTEREST GROUP REPORTERS

Biomaterials & Medical Products Commercialization	Puneeth Shridhar • pus8@pitt.edu
Biomaterials Education	Sarah Rowlinson • sarcorow@gmail.com
Biomaterial-Tissue Interaction	Antonio Merolli • antonio.merolli@rutgers.edu
Cardiovascular Biomaterials	Chris Bashur • cbashur@fit.edu
Dental/Craniofacial Biomaterials	TBD
Drug Delivery	Eun Ji Chung • eunchung@usc.edu
Engineering Cells & Their Microenvironments	Scott Wood • scott.t.wood@gmail.com
Immune Engineering	Yaoying Wu • yw195@duke.edu
Nanomaterials	Eno Ebong • e.bong@northeastern.edu
Ophthalmic Biomaterials	Frances Lasowski • lasowsfj@mcmaster.ca
Orthopaedic Biomaterials	Roche C. de Guzman • roche.c.deguzman@hosftra.edu
Protein & Cells at Interfaces	Rafael Ramos • ramos.rafael93@gmail.com
Surface Characterization & Modifications	Gopinath Mani • gmani@sjm.com
Tissue Engineering	Abby Whittington • awhit@mse.vt.edu



Contents

THE TORCH

NEWS & UPDATES

ON THE COVER

A young adult male who had previously undergone an instrumented fusion from his upper cervical to upper thoracic spine as a result of a motor vehicle accident presented with neck pain and weakness. Prior to his revision surgery, he had no preoperative signs of infection. However, after his hardware was removed, *Staph* was identified at every level and P. *acnes* was found at C6 and T1. Courtesy of Dr. Celeste Abjornson, Hospital for Special Surgery, New York, New York.

From the Editor

INTERESTING PERSPECTIVES ON PEER REVIEW

By Guigen Zhang, Editor, SFB Forum

Recently, I read an article in the *Washington Post* (Aug. 1, 2019) titled, "Why We Shouldn't Take Peer Review as the 'Gold Standard,'" by Paul D. Thacker and Jon Tennant. It is an interesting read and points out the good, the disappointing, and the politicizing sides of a review process we value so much. As the authors pointed out, we know too well the limitations of such a process, that it is not perfect but still the best process we have at our disposal. It may be a good thing to bring our attention, from time to time, to these various good and not-so-good aspects of the peer review process because they may remind us of the need to keep searching for a better process. In light the digital openness of today's connected world, would transparency and public opinion help improve the situation or just make it worse? Below are some excerpts from the article:

In July, India's government dismissed a research paper finding that the country's economic growth had been overestimated, saying the paper had not been "peer reviewed." At a conference for plastics engineers, an economist from an industry group dismissed environmental concerns about plastics by claiming that some of the underlying research was "not peer reviewed." And the Trump administration — not exactly known for its fealty to science — attempted to reject a climate change report by stating, incorrectly, that it lacked peer review.

Meanwhile, bad actors exploit the process for professional or financial gain, leveraging peer review to mislead decision-makers. For instance, the National Football League used the words "peer review" to fend off criticism of studies by the Mild Traumatic Brain Injury Committee, a task force the league founded in 1994, which found little long-term harm from sport-induced brain injuries in players. But the New York Times *later discovered that the scientists involved had omitted more than 100 diagnosed concussions from their studies. What's more, the NFL's claim that the research had been rigorously vetted ignored that the process was incredibly contentious: Some reviewers were adamant that the papers should not have been published at all.*

A few years ago, it emerged that Willie Soon, a scientist at the Harvard-Smithsonian Center for Astrophysics, had accepted $1.2 million from fossil fuel interests to publish studies, which he described as "deliverables," in academic journals. (Much of his research has argued that variations in the sun's energy can explain most recent global warming and that humans have had little effect on climate change, a thesis rejected by the majority of experts.) Peer review did not uncover these vested relationships: The editor of the Journal of Atmospheric and Solar-Terrestrial Physics *told a reporter that it relied on authors to be truthful about conflicts of interest.*

Peer review has also sometimes stymied important research. Senior scientists are more likely to be asked to assess submissions, and they can shoot down articles that conflict with their own views. As a result, peer review can act as a shield to protect the status quo and suppress research viewed as radical or contrary to the established perspectives of referees. A 2015 study of 1,000 medical journal submissions found that of the papers that were eventually published, the 14 that became the most frequently cited were initially rejected. Groundbreaking studies by Sir Frank MacFarlane Burnet, Rosalind Yalow, Baruch Blumberg and others were rejected by peer reviewers, yet later led to Nobel Prizes.

Hopefully, reading this letter will stimulate some good ideas. In closing, let me briefly tell you what we have prepared for you in this issue. SFB President, Horst von Recum provides an update on the strategic planning discussions at a recent SFB Board and Council meeting. You will catch up with Members in the News, prepared by Cherie Stabler, SFB member-at-large, get a staff update by Brittany Noll, read student news by Jason Guo, and get updates from the Tissue Engineering SIG and Biomaterials Education SIGs. You will read refections from this year's the two Cato T. Laurencin Travel Fellowship recipients. In our regular columns, you will read industry news and government news. In Memoriam, we share with you reflections by Tony Mikos on remembering Joe Salamone, a pioneer and giant in the field of biomaterials. In Meet the Rising Stars, we feature an interview with Stephanie Seidlits, the recipient of the 2019 SFB Young Investigator Award. In this issue, we also share with you Matt Libera's take on the conference on bacteria-material interactions held at the Stevens Institute. I would also encourage all SFB members to share similar reflections and updates from biomaterial-related scientific gatherings and meetings you had in your regional events.

With best wishes,

Guigen Zhang

From the President

By Horst von Recum, SFB President

Greetings SFB Members,

Hope you all had an enjoyable and productive summer. SFB Board and Council held our strategic planning meeting virtually this summer and reviewed some of the trending drivers of change in the association industry. This examination of the Foresight Initiative from the American Society of Association Executives provides a framework to evaluate the state of our membership and what major influences are expected in the near and mid-term future. From open access journal publishing to addressing issues of diversity and inclusion, the ever-changing landscape in which we operate was examined in the context of our field, and our Society. We›ll be working on a series of initiatives within the current committee structure and creating a new Diversity and Inclusion task group, which will ultimately become a committee in 2021. If you'd like to get involved in a SFB Committee or task force, please either contact headquarters at info@biomaterials.org, or go online and adjust your profile on the website to reflect your desired committee participation.

As a reminder, there will not be a national meeting for SFB in the U.S. this year. Instead, we are taking part in the World Biomaterials Congress (WBC), hosted by the European Society for Biomaterials in Glasgow, UK, May 19-24, 2020. Many of you have already been involved in helping propose and organize sessions for that meeting- thank you for all your hard work. The U.S. made a good showing in the session submissions. The call for abstracts for the WBC was recently sent so keep an eye out for that. If you didn't receive the email from SFB Headquarters, you can find more details here: https://wbc2020.org/abstracts/call-for-abstracts

Even without our annual meeting, there is still plenty to do! I will be working with council this coming year to collect information on where our members are located so that we can better understand who our membership is and whether we are engaging all the folks in our field. We'll also be performing survey work with lapsed members to determine why they haven't renewed. If you hear from us, your assistance with quick, helpful responses is greatly appreciated. If you have any anecdotal feedback about the motivation to join/renew your membership with SFB, please share it! We're particularly interested in what members find most valuable, whether or not it's among our current offerings.

Lastly, there will be a small workshop in Hawaii co-hosted by SFB and the Japanese Society for Biomaterials December, 10-12, 2020. This workshop is purposely held adjacent to Pacifichem 2020. Look for additional details coming soon.

With that, I wish you the best for the Fall.

Horst von Recum

ATTENTION MEMBERS!

WE WOULD LOVE TO HEAR FROM YOU.

IF YOU HAVE NEWS TO SHARE WITH FORUM READERS, LET US KNOW. EMAIL YOUR NEWS AND ANY PHOTOS TO INFO@BIOMATERIALS.ORG AND YOU COULD BE FEATURED IN THE NEXT ISSUE.

In Memoriam: JOE SALAMONE

By Tony Mikos, Rice University

The biomaterials community sadly acknowledges the passing of Dr. Joseph C. Salamone, the outstanding pioneer of ophthalmologic and wound healing applications of gas-permeable polymeric materials.

Dr. Salamone first revolutionized the understanding and progress of these fields when he harnessed an expertise in polymer chemistry and imaginative synthetic chemistry techniques to invent oxygen-permeable rigid contact lenses in the late 1970s. By cofounding the Polymer Technology Corporation and Rochal Industries (the latter named for his three children), he then crucially enabled the commercialization of these products, along with more than 40 additional products ranging from intraocular lenses and ophthalmologic cleaning solutions to spray-on liquid bandages for dermatologic wounds. The holder of more than 200 U.S. patents and 800 international patents, Dr. Salamone was recognized by our Society for his far-reaching contributions and tangible impact on human healthcare with the Clemson Award for Applied Research in 2006 and the Technology Innovation and Development Award in 2016.

In addition to his participation in the Society For Biomaterials Tissue Engineering SIG, Dr. Salamone was a member of the National Academy of Engineering and National Academy of Inventors. He also served as an active Fellow of the American Chemical Society's Division of Polymer Chemistry, as well as the Industry Council of the American Institute for Medical and Biological Engineering. Known as a riveting lecturer and one who readily encouraged early career faculty toward their own research initiatives, Dr. Salamone has also been associated with many educational institutions, serving as dean for the University of Massachusetts Lowell. Providing an unmatched example of developing a biomedical technology from conception to realization, his life's work of translating insight in material chemistry has benefited the sight of innumerable patients.

Member News

By Cherie Stabler, Member-at-Large

I am honored to serve as your 2019-20 member-at-large! In this role, I will strive to provide your collective voice to the SFB Board of Directors and Council. In this role, I hope to support and expand our supportive and engaging community with broad, diverse membership engagement. Please feel free to share your ideas and concerns with me directly at cstabler@bme.ufl.edu.

This quarter's exciting member news and accomplishments include the following:

Guillermo A. Ameer, professor of biomedical engineering and surgery at Northwestern University, has been named the 18th recipient of the Martin E. and Gertrude G. Walder Award for Research Excellence. Ameer was recognized for his contributions to the field of regenerative engineering, including the design of biodegradable materials that promote tissue regeneration and prevent scarring.

Danielle Benoit, an associate professor of biomedical engineering, was recently awarded the College Award for Undergraduate Teaching and Research Mentorship at the University of Rochester. This award acknowledges a tenured faculty member in arts, sciences and engineering who excels as a scholar, teacher and mentor of undergraduate students.

Adam Feinberg, a professor of biomedical engineering (BME) as well as materials science and engineering at Carnegie Mellon University, and his colleagues recently published their work on a 3D printing approach for printing cells and collagen with unprecedented resolution and fidelity in the journal *Science*. The technique, known as freeform reversible embedding of suspended hydrogels (FRESH), permits 3D bioprinting methods using soft and living materials. The team demonstrated the capacity of FRESH to translate magnetic resonance imaging data from a human heart into a 3D structure using collagen and human heart cells. DOI: 10.1126/science.aav9051

Michael Gower, assistant professor of chemical and BME at the University of South Carolina, recently published a manuscript in *Biomaterials* outlining the use of poly(lactic-co-glycolic acid) scaffolds for the systemic modulation of blood glucose levels. Implantation of these scaffolds into mouse fat pads decreased obesity and improved glucose regulation, demonstrating the feasibility of using "empty" scaffolds as therapeutic implants for metabolic diseases. DOI: 10.1016/j.biomaterials.2019.119281.

Amol Janorkar, professor and graduate program director of biomedical material science at the University of Mississippi Medical Center, was recently awarded the Outstanding Young Alumni Award from the Clemson University College of Engineering, Computing and Applied Sciences.

Christopher Jewell, associate professor and associate chair of bioengineering at the University of Maryland, recently received the Presidential Early Career Award for Scientists and Engineers (PECASE). The PECASE is the highest honor bestowed by the U.S. government to outstanding early-career scientists and engineers who show exceptional leadership potential in science and technology. Jewell, who was nominated by the National Science Foundation, was recognized for his innovative research integrating immunology and biomaterials to develop vaccines for cancer and autoimmune diseases. Jewell was also recently awarded two new National Institutes of Health (NIH) R01 Bioengineering Research Grants. These grants, funded by the National Institute of Allergy and Infectious Diseases (NIAID) and National Institute of Biomedical Imaging and Bioengineering (NIBIB), support projects on drug compliance challenges facing patients with multiple sclerosis (NIAID) and rational adjuvant design for cancer vaccines (NIBIB).

Benjamin Keselowsky and **Gregory Hudalla**, professor and associate professor of BME, respectively, at the University of Florida, were recently awarded first place in the 2019 Cade Prize from the Cade Museum for Creativity and Invention for their co-founded company, Anchor Biologics. The goal of this company is to create a new biomaterial treatments for inflammatory diseases.

Bruce Lee, associate professor of BME at Michigan Technological University, and his graduate student, Ameya Narkar, were recently awarded the Bhakta Rath Research Award. This award honors a graduate student and faculty mentor for in-depth work with social impact.

David K. Mills, professor and director of BioMorPH at Louisiana Tech University, was recently awarded a grant from the Louisiana Biomedical Research Network in the area of translational medicine. The objective of this project is to fabricate a customized drug-eluting and biodegradable implant (e.g., resorbable bone mesh, screws and plates) using 3D printing technology. If successful, resulting products will provide novel, cost-effective and customizable medical devices for use in the treatment of developmental or traumatic craniomaxillofacial defects or injuries.

Member News (continued)

Michael J. Moore, associate professor of BME at Tulane University, was recently awarded the Suzanne and Stephen Weiss Presidential Fellows Awards for Undergraduate Teaching at Tulane University. This award recognizes excellence in undergraduate teaching, student advising and instructional improvement and development.

Nicholas Peppas, the Cockrell Family Regents chair in engineering and professor of chemical engineering at the University of Texas at Austin, was recently inducted into the Canadian Academy of Engineering. Peppas was recognized for his research contributions in the area of biomaterials for artificial organs and drug delivery; the study of biomedical transport phenomena; and in the design of recognitive, responsive and intelligent biomedical devices.

Anirban Sen Gupta, professor of BME at Case Western Reserve University, was recently awarded two new grants from NIH. The first, a multi-PI R01 grant with Prithu Sundd, Melanie Scott and Matthew Neal at the University of Pittsburgh, seeks to study the mechanisms of platelet exosome-mediated acute chest syndrome in sickle cell disease. The other grant is an NIH Phase 1 Small Business Innovation Research grant lead by Haima Therapeutics, a company co-founded by Gupta and Christa Pawlowski to advance synthetic platelet technologies for hemorrhage control. The team will use this grant to evaluate synthetic platelet dosing in treating thrombocytopenia. Gupta and his research team were also recently awarded the 2019 Case School of Engineering Innovation Award.

Kelly Stevens, assistant professor in the departments of Bioengineering and Pathology at the University of Washington, and **Jordan Miller**, assistant professor of bioengineering at Rice University, lead a team of researchers on a 3D printing approach for designing elegant microvasculature that was recently published in the journal *Science*. Their bioprinting technology, termed stereolithography apparatus for tissue engineering (SLATE), uses additive manufacturing to make soft hydrogels one layer at a time. With proof-of-concept studies in benchtop and animal models, this approach could be used to generate customized vascular structures for engineering functional tissues. DOI: 10.1126/science.aav9750

Member **Richard Youngblood**, with his advisor **Lonnie Shea**, professor and chair of BME at the University of Michigan, recently published a manuscript in *Acta Biomaterialia* using a 3D microporous scaffold as a niche to direct pluripotent stem cells toward insulin-producing β-cells for the treatment of people with type 1 diabetes mellitus. DOI: 10.1016/j.actbio.2019.06.032

Guigen Zhang, professor and chair of the F. Joseph Halcomb III, MD Department of Biomedical Engineering at the University of Kentucky, and postdoctoral student **Yu Zhao** recently published a manuscript in *Acta Biomaterialia* on the dual effect of intermittent and continuous administration of parathyroid hormone on bone remodeling. This modeling work provides valuable insights into the influence of temporal control of parathyroid hormone (PTH)/PTH-related protein on bone mass and presents a possible path toward bridging bioengineering approaches with clinical treatment strategies. DOI: 10.1016/j.actbio.2019.04.007.

Ruogang Zhao, assistant professor of BME at the University of Buffalo, recently published a manuscript in *Nature Communications* describing a microfluidic system that mimics dynamic changes in clot mechanisms under physiologic flow conditions. This device, termed clotMAT, could be used in the future as a diagnostic tool for bleeding disorders. DOI: 10.1038/s41467-019-10067-6.

Staff Update

By Brittany Noll, Assistant Executive Director

Hello from the Society For Biomaterials headquarters! SFB's governing council held strategic planning calls on July 10 and July 11, 2019, with an eye on the future. As the new program year gets underway, the Society's Board of Directors, governing council, committees, task forces and SIGs will be working to advance the Society's strategic plan. (A PowerPoint summary of the Strategic Plan is available under the About menu on the SFB website.)

AWARDS, CEREMONIES & NOMINATIONS COMMITTEE

Chair: Liisa Kuhn, PhD

The committee solicited nominations for 2020. Award nominations closed on September 13, 2019, and officer nominations closed on September 20, 2019. Award nominations are currently under review for announcement of selected recipients to be made in late November. Officer nominations, once formalized by the committee, will be forwarded to the council for ratification. Approved candidates will stand for election in early 2020.

BYLAWS COMMITTEE

Chair: Ashley Carson Brown, PhD

The committee will be reviewing the bylaws and discussing any possible amendments, including the addition of a Diversity and Inclusion Committee.

EDUCATION & PROFESSIONAL DEVELOPMENT COMMITTEE

Chair: Anirban Sen Gupta, PhD

The committee will be reviewing submissions for 2020 Biomaterials Day grants. Applications were due by September 14, 2019, and funding will be announced in November. The committee will also be overseeing the activities of the Young Scientist Group and the National Student Chapter as both groups prepare plans for the World Biomaterials Congress in Glasgow.

FINANCE COMMITTEE

Chair: Sarah E. Stabenfeldt, PhD

The Society is enjoying a good year with strong income from the Annual Meeting in Seattle. Income and expenses are in line with the budget, and the Society is projecting a healthy operating net income in 2019. SFB is preparing the 2020 budget to include World Biomaterials Congress support activities, the Biomaterials Day program, webinars and the Fall Symposium being held in Honolulu, Hawaii, from December 11 to 13, 2020!

INDUSTRIAL AFFAIRS COMMITTEE

Chair: SuPing Lyu, PhD

The committee will be reviewing matters of particular concern to the manufacture of biomaterials and will hold discussions related to the availability of implantable materials. The committee is also charged with polling industry members to determine interest in and topics for webinars in 2020.

LIAISON COMMITTEE

Chair: Tim Topoleski, PhD

The committee is evaluating endorsement requests and considering activities in conjunction with the World Biomaterials Congress, as well as collaborations with other organizations.

MEMBERSHIP COMMITTEE

C. LaShan Simpson, PhD

Current membership stands at 1,327; at this time last year, membership was 1,361 and 1,161 in 2017. While some fluctuations are to be expected, there does appear to be a clear trend of increasing student attendance at the Annual Meeting. The committee continues to develop strategies to increase membership, especially focusing on industry and clinical sectors.

PROGRAM COMMITTEE

Chairs: Elizabeth Cosgriff-Hernandez, PhD, and Nicholas P. Ziats, PhD

The committee is finalizing plans for a 2020 Fall Symposium with the Japanese Society For Biomaterials to be held in Honolulu, Hawaii, from December 11-13, 2020. The call for abstracts will be distributed in the first quarter of 2020.

PUBLICATIONS COMMITTEE

Chair: Sachin Mamidwar

The committee is reviewing the relationship between SFB and Wiley and considering the impact of open access publications on the Society's financial model and the scientific community in general. More deliberation and analysis are needed as the situation develops and new information becomes available. This societal trend may well impact the way the Society operates in the future.

SPECIAL INTEREST GROUPS

Representative: Danielle Benoit, PhD

SIGs have submitted proposals for the 2020 World Biomaterials Congress and planned their budgets for 2020.

If you have any questions,

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

SOCIETY FOR BIOMATERIALS
1120 Route 73, Suite 200 | Mount Laurel, NJ 08054
Phone: 856-439-0826 • Fax: 856-439-0525
Email: info@biomaterials.org

Student Chapter News

By Jason Guo, National Student Chapter President

HELLO FROM THE NEW NATIONAL STUDENT CHAPTER OFFICERS!

Greetings SFB student members and all! It is my honor to introduce our new National Student Chapter officers for 2019 – 2020, as well as our newly elected officers for the 2020 – 2021 term:

- President: Jason Guo (Rice University)
- Secretary/Treasurer: James Shamul (University of Maryland)
- Bylaws Chair: Zahra Davoudi (Iowa State University)
- President-Elect: Deanna Bousalis (University of Florida)
- Secretary/Treasurer-Elect: Sabrina Freeman (University of Florida)

Our team is excited to plan new workshops, networking events and other programming for our student members at the upcoming World Biomaterials Congress (WBC) in 2020 and Society For Biomaterials Annual Meeting in 2021. Our priorities for the upcoming year include developing conference resources for training your communications and interpersonal skills as young researchers and building networks with a global mindset in the 21st century.

Without spoiling too much, we can tell you that we've been working with SFB's Young Scientist Group to plan some exciting formal and informal content for WBC 2020. Our plan for this conference is to take advantage of its uniquely international nature to give you opportunities for dialogue and networking with peers and leaders within the field you might otherwise not be able to see. We think it'll be a valuable opportunity for any student member of SFB and hope that you can all attend! You can, of course, keep an eye out for updates on our plans for WBC in future issues of the *Biomaterials Forum*.

HOW CAN I GET INVOLVED?

We believe that one of the most valuable opportunities for professional development and network building is your involvement in academic societies like SFB. In addition to connecting with peers, academic leaders and industry leaders outside of your own institution, you get a unique opportunity to develop communications and management skills that nicely supplement your training as a researcher. So how can you get involved?

SIGs are one easy way to actively participate in the Society. As student members, you have *free* admission to join any SIG of your choice and can also serve as a student representative for these SIGs. If you're interested, I encourage you to reach out to the chair of your SIG and express your interest in contributing a student perspective to SIG programming as a student representative. Many student representatives even get the chance to co-chair conference sessions, which is a valuable opportunity for student leadership that also looks great on your CV. You can always submit ideas of your own as well for workshops and sessions to SFB-sponsored conferences, though it's always helpful to pair yourself with a faculty co-chair.

Biomaterials Days are another great way to gain leadership experience as part of SFB. They're also a great way to contribute to your campus community by bringing in industry and academic leaders for people to connect with. My university (Rice University) recently hosted a Biomaterials Day, and I can tell you that the talks, posters and mixers were really well-enjoyed. Our appreciation, of course, goes to SFB for helping us make our Biomaterials Day a success through its sponsorship and guidance. For more information, including details on the Biomaterials Day grant that can award up to $2,500 for programming, please see the most up-to-date webpage at https://www.biomaterials.org/students/biomaterials-days.

CONNECT WITH US!

Another great way to participate in SFB as a student is to connect with us, your student chapter officers! You're always welcome to reach out to us if you have any ideas for programming that can better serve your needs as young scientists and researchers. My inbox is open to all, and you can contact me at JLG19@rice.edu with any ideas or suggestions. You can also find SFB and its members on social media, including Facebook, LinkedIn and Twitter. More information on these social media outlets can be found at https://www.biomaterials.org/about-about-society/sfb-social-media.

Update from the Tissue Engineering SIG

A CELEBRATION OF INTERNATIONAL WOMEN IN ENGINEERING DAY

By Ngan F. Huang, Department of Cardiothoracic Surgery, Stanford University, and Allison Ferreri, Department of Bioengineering, University of Colorado Denver Anschutz Medical Campus

On June 23, 2019, we celebrated International Women in Engineering Day, a day that highlights the achievements of women in engineering and inspires the next generation of young women to join this exciting field. This awareness campaign was initiated in 2014 by the Women's Engineering Society with the theme #TransformTheFuture. In addition, #INWED2019 was associated with a large number of Twitter entries from both industry and academia. Some contributors gave personal advice to trainees, and others highlighted the engineering accomplishments of women.

Among the social media entries included those associated with tissue engineering. For example, Dr. Anita Ghag from the University of Birmingham was highlighted for her research in novel biomaterials for bone tissue engineering. Research Fellow Dr. Lu Luo, also from the University of Birmingham, was featured for her research in treating osteoporosis using tissue engineering and regenerative medicine. As part of the Nature Bioengineering Research Community, I shared a post describing my path toward a career in tissue engineering and provided some advice for women beginning a career in this path. More broadly in the field of bioengineering, other contributors, such as Dr. Julie Audet from the University of Toronto, shared about mentors who inspired them. As we look toward the future of women in engineering, we are hopeful that the future will remain bright.

Dr. Huang's laboratory consists of a large number of female researchers.

UNIVERSITY OF COLORADO DENVER ANSCHUTZ MEDICAL CAMPUS HOSTS "WOMEN AS INNOVATORS" SYMPOSIUM

International Women in Engineering Day underscores the importance of representation in engineering and shows how coming together to highlight achievements of women in STEM has the power to inspire and uplift the next generation of engineers.

It is a privilege to advance a more equitable future for engineering, and it is crucial that academia takes a strong role in helping train a workforce ready to make that goal a reality. In February of this year, the Department of Bioengineering at the University of Colorado (CU) Denver Anschutz Medical Campus attempted to do just that.

The Department of Bioengineering, of which 42 percent of students are female, hosted a groundbreaking symposium entitled "Women as Innovators: Creating Success in the Workplace." The day-long event featured an array of inspiring women, including Colorado Women's Hall of Fame inductees; chairs for diversity and inclusion for the School of Medicine and CU Denver; several female CEOs in industry; Department of Bioengineering alumni; and CU Denver's chancellor, Dr. Dorothy Horrell. Speakers covered issues from implicit bias to professionalism to self-care in the symposium, the first event of its kind for CU Denver Anschutz Medical Campus. Throughout the event, the mission of "Women as Innovators" was to uplift and empower all attendees and encourage the group to build an equitable future by celebrating diversity and fostering inclusion in STEM.

"Women as Innovators" sold out within days, and participants packed the event space to full capacity in its inaugural year. Encouragingly, the event was attended by not only students and faculty from the Department of Bioengineering but also members from other departments in the CU Denver College of Engineering, Design and Computing; members from the Colorado School of Medicine and the Colorado School of Public Health; and researchers, staff and faculty from across disciplines on the medical campus. Following the event, participant feedback was overwhelmingly in favor of "Women as Innovators" becoming an annual event. The Department of Bioengineering plans to host "Women as Innovators" again in spring 2020, with an expanded reach beyond engineering and into the broader range of STEM fields represented at the Anschutz Medical Campus — and in a larger event space.

Bioengineering alumni panel members discuss their experiences in industry. Photo taken by Kate Hoch.

Biomaterials Education Update

WHAT IS BIOMEDICAL ENGINEERING, ANYWAY? A NEEDS-BASED APPROACH TO CURRICULUM DESIGN

By Nicole Friend and Aileen Huang-Saad, Transforming Engineering Education Laboratory, Department of Biomedical Engineering, University of Michigan

Biomedical engineering (BME) is a complex, ever-evolving, interdisciplinary field that brings together clinical faculty and researchers from various backgrounds to address healthcare needs. Although a thriving field, students graduating from BME programs often express concern about their career prospects.[1] This is likely the result of BME undergraduate curricula lacking significant exposure to the diverse BME post-graduate opportunities in students' early years. Indeed, when undergraduates are only exposed to BME-specific topics and hands-on skills during their upperclassman years, it can be *too little, too late*. This leaves students without a true sense for what the field of BME is until they are well on their way to applying for career-building opportunities, which may cause students to struggle with communicating the value of their abilities to potential employers. Furthermore, in BME curricula where students must choose to specialize in a specific concentration or track within the first few years, students may find it difficult to make this decision with limited previous exposure to BME material. Students may not be aware that they are choosing a concentration that is less than ideal for them until it is, again, too late. Instead, they focus more on meeting degree requirements for graduation with the courses they have already completed, rather than switching to a more appropriate concentration. Despite student concern demonstrating a clear need for educational reform, curricula often remain stagnant, as faculty have little time to continuously create new courses that meet the changing demands of an evolving field.

At the University of Michigan, we have been working to find ways to tackle these challenges by providing first- and second-year undergraduate students early exposure to important BME topics. By doing this, we hope that students will develop a stronger understanding of what BME is as a field and gain hands-on skills earlier in their undergraduate careers to allow earlier access to BME career-building opportunities beyond the required curriculum, such as research experience or internships. This is done through an **iterative instructional design sequence** in which teams of upper-level undergraduates, graduate students, postdocs and faculty members participate in the instructional design process to develop multiple one-credit, four-week **BME-in-practice** modules. These modules are then offered to students the following semester and co-taught by the student and postdoctoral team who developed them. This ultimately lessens the burden of new course creation and instruction placed on faculty, while offering graduate students, postdocs and future academics mentored experiences in course design and instruction.

"THESE MODULES HAVE INTRODUCED STUDENTS TO MULTIPLE ASPECTS OF BME, AND BECAUSE THEY ARE ONLY FOUR WEEKS LONG, STUDENTS CAN TAKE MULTIPLE MODULES IN A SINGLE SEMESTER. THIS ALLOWS STUDENTS TO MAKE INFORMED DECISIONS ABOUT SELECTING THE BME CONCENTRATION THEY WANT TO PURSUE AND THE TYPE OF CO-CURRICULARS THEY MAY WISH TO PARTICIPATE IN TO EXPAND THEIR SKILL SETS."

However, with an interdisciplinary, constantly evolving field like BME, it may be challenging to narrow down what topics are important enough to be incorporated into new courses. To address this challenge, a needs-based approach to curriculum design is taken to ensure that developed modules provide students with specific skills that make them more marketable to future employers. Teams are tasked with interviewing BME stakeholders, including representatives of academia and industry, to identify the critical skills and best practices necessary for student success after graduation. Through these interviews, participants gain valuable insight into the important technical skills, interpersonal skills and content potential employers would like to see in our graduates. Teams also interview undergraduate students to determine what they would like to see incorporated in their curriculum. With this knowledge, modules are designed to map identified needs to course content through engaging lectures and hands-on activities. Throughout the modules, teaching teams strive to communicate exactly how the skills students are learning may be applicable to future BME opportunities. Many teams also elect to include a panel of faculty, graduate students or industry representatives to interface with

Biomaterials Education Update (continued)

students and emphasize what opportunities in BME look like, how students may go about finding these opportunities and what skills are important to possess.

In addition to developing relevant course content, teams are mentored in methods of effective teaching and concepts of student-centered learning. This is pivotal to ensure that high-level ideas are communicated to less-experienced students in a digestible and engaging manner. Furthermore, modules are designed to provide students a low-stakes environment to explore BME and create a sense of community. Course assignments serve as formative assessments that allow the teaching teams to learn what material students understand and what may need to be reinforced. Participation scores are emphasized to encourage student engagement, and lectures incorporate active learning strategies that enable students to collaborate to answer class questions or formulate project ideas. The small class size, usually 10 – 15 students, encourages students to interact with the teaching team. Since the teams are composed of upperclassman undergraduates, graduate students and postdocs, module students are often more comfortable having these interactions than they would be with a professor in a traditional classroom setting. This environment is explicitly cultivated to create a sense of belonging and encourage students to focus more on learning important skills and concepts and less on earning high course grades.

As the design of BME-in-practice modules is facilitated through a course offered every fall term, the modules developed are constantly evaluated and remodeled, offering an iterative approach that allows for needs-based curriculum design. Modules that are both successful and remain relevant will likely be improved on for the following year. Those that are not successful are replaced with new modules that fulfill current stakeholder needs. These modules have introduced students to multiple aspects of BME, and because they are only four weeks long, students can take multiple modules in a single semester. This allows students to make informed decisions about selecting the BME concentration they want to pursue and the type of co-curriculars they may wish to participate in to expand their skill sets.

Table 1. Instructional Design Sequence Participants

TYPE OF PARTICIPANT	NUMBER
Faculty	3
Postdocs	3
PhD Students	12
Master's Students	15
Fourth-Year Undergraduate Students	3
Total	36

Over the past two years, there have been 36 participants in the instructional design sequence (Table 1) and 64 students enrolled in the BME-in-practice modules. Five unique modules were offered: tissue engineering, medical device development, computational modeling for drug development, regulations and neural engineering. Tissue engineering and medical device development were each iterated upon and offered both years. Several students enrolled in multiple modules, resulting in 50 unique students enrolling in the modules, 73 percent of whom were women. Qualitative results from module participants indicate that their initial expectations were exceeded. Students appreciated the hands-on learning early in their curriculum as well as the development of community. Several students also attributed their ability to secure summer opportunities in BME to their experience in the modules. Interestingly, upper-level and graduate students have expressed interested in enrolling in the modules as well. Preliminary results suggest that there is significant value to the instructional design sequence for curricular change and career development for both undergraduate and graduate students. Several research projects are underway to further evaluate the educational impact of the instructional design sequence. More information on the sequence can be found at teel.bme.umich.edu.

REFERENCE:

1. Berglund J. The real world: BME graduates reflect on whether universities are providing adequate preparation for a career in industry. *IEEE Pulse*. 2015;6(2): 46-49.

2019 Biomaterials Education Challenge

The Biomaterials Education Challenge encourages and challenges Society For Biomaterials student chapters and other student clubs or groups to develop innovative and practical approaches to biomaterials education for middle school (6th-8th grade) science classes. Teams are challenged to develop an educational module that will both improve widespread understanding of biomaterials-related science as well as expose students to potential career opportunities. Modules are expected to be engaging, hands-on learning experiences which demonstrate fundamental biomaterials concepts, easily completed within a 45-minute class period; learning objectives should be clearly understood and materials easily obtained.

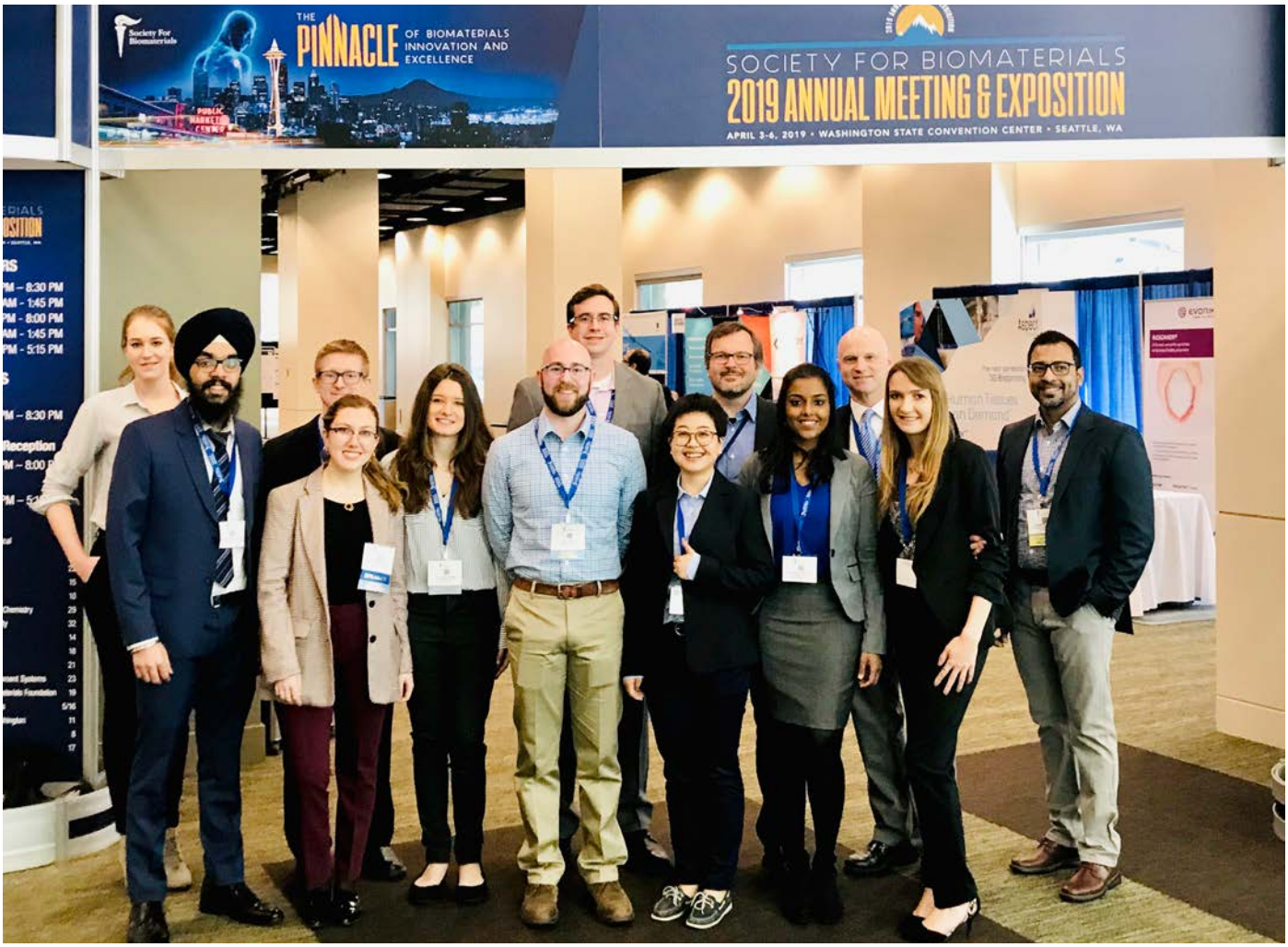
Winners emphasize innovation, practicality, and the likelihood of widespread adoption and dissemination, through demonstration of educational impact. Finalists are selected based on the submitted abstracts to present a poster to the panel of judges.

This year's Biomaterials Education Challenge was held at SFB's 2019 Annual Meeting & Exposition in Seattle, Washington. Below are the results of the challenge:

First Place: University of Florida, Gainesville, FL
Second Place: Texas A & M University, College Station, TX
Third Place: Vanderbilt University, Nashville, TN

**Judges: Dr. Daniel Alge, Dr. Joel Bumgardner, Dr. Jan Stegemann, Dr. Bill Murphy, and Dr. Anirban Sen Gupta.*

Thanks to all who participated and a big congratulations to the winners! To view all of the Education Challenge materials, click here: https://www.biomaterials.org/students-biomaterials-education-challenge/past-biomaterials-education-challenge-winners-and



2019 participants of the Biomaterials Education Challenge, during the 2019 SFB Annual Meeting & Exposition in Seattle, Washington.

OUTREACH LESSON TO SHARE

Osseous biomaterials: When your bone needs help healing

University of Florida Society For Biomaterials Student Chapter

STATEMENT OF PURPOSE

Current K-12 curricula lack significant depth in materials science yet has tremendous room for its incorporation[1]. In fact, middle school curricula are especially positioned for the inclusion of biomaterials concepts when students study the different organ systems of the body[1]. Our lesson is specifically designed as a companion lesson to those that teach the structure and function of bone. For our lesson, we reframe the study of bone through the lens of a materials engineer to focus on its structure-property-function relationships and the use of metallic biomaterials for orthopedic applications giving specific focus to their interactions. This lesson is targeted at 6th and 7th grade students with classroom sizes of 20 – 30 students. Nonetheless, it is scalable to older and younger students by incorporating more or less higher-level concepts. The learning objectives for the lesson are:

1. Identify that bone,
   a. is a composite material
   b. has a hierarchical structure
   c. is a living material composed of cells
2. Identify that metallic implants,
   a. are made from different metals for specific reasons
   b. can lead to stress shielding
3. Define stiffness, strength, and fracture
4. Compare material classes
5. Relate material properties to implant performance
6. Design stiff, stable composite structures

The lesson describes the properties of bone and metallic biomaterials with the aid of demonstrations, a hands-on engineering design challenge, and an interactive, web-enabled student assessment.

components of bone being a composite of a collagen (soft gel material) and hydroxyapatite (stiff ceramic material). This leads into (2) which describes how these two components are organized in a hierarchical structure. An analogy to an office building is used to explain the concept of hierarchy (**Figure 1**). Lastly, in (3) the cellular component of bone is discussed to introduce that bone has three general cell types: osteocytes, osteoblasts, and osteoclasts, and their specific functions in remodeling.

Figure 1.

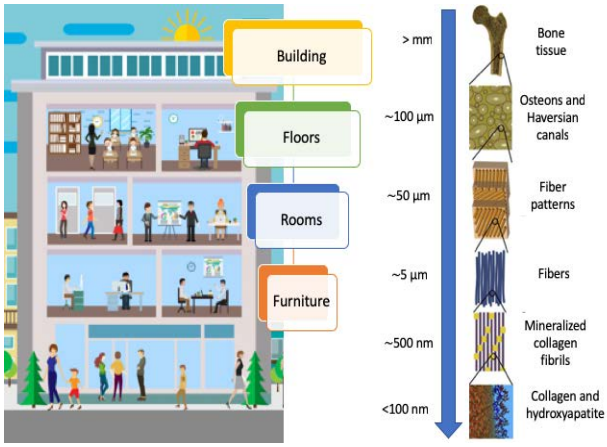
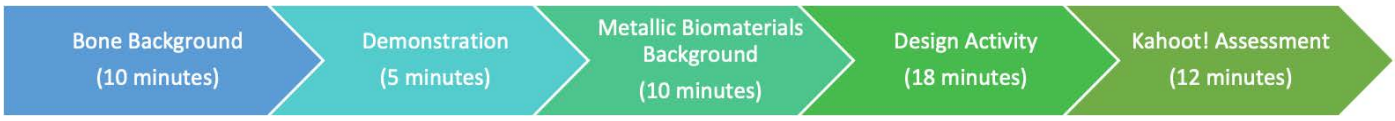


Diagram of hierarchical structure using the example of a building's hierarchical organization being analogous to that of bone's hierarchical structure.

As for metallic biomaterials, a short video titled, "'Smart implants' dissolve after healing," produced by the National Science Foundation for the *Science Nation* series is played to introduce the use of metals for orthopedic applications. Not only is this video pertinent to the topic, it also highlights traditionally underrepresented minorities in STEM fields in the role of the biomaterials engineer. Afterwards, several different metallic biomaterials are discussed including, steel, titanium, aluminum, and cobalt-chromium. During this time, students learn about stress shielding with a hands-on demonstration and materials selection.



DESCRIPTION OF ACTIVITY METHODS INCLUDING MATERIALS AND BUDGET

Specifically, the properties of bone related to its strength are presented to students including that bone 1) is a composite material, 2) has a hierarchical structure, and 3) is a living/dynamic material consisting of a cellular component. In (1) students learn about the properties of *elasticity* and *fracture* as they relate to soft and stiff materials. Marshmallows (soft, ductile material) and ceramic mugs (stiff, brittle material) are used to convey the differences in material properties and relate to the two main

All of these concepts are presented using a multitude of approaches: lecture, demonstration, and activity. General content is presented using a PowerPoint presentation. Throughout, students are engaged with questions posed on the slides such as, "Have you ever broken a bone?" and, "What

Osseous biomaterials: When your bone needs help healing (continued)

do you think bone is made from?" To further reinforce the material property concepts of elasticity and fracture, in-class demonstrations of squeezing marshmallows and dropping ceramic mugs are employed. Students are especially excited to see the ceramic mug shatter. Likewise, a simple demonstration to convey the concept of stress shielding is conducted using a roll of toilet paper and a heavy textbook (**Figure 2**). For this the students are grouped into teams of 3-4 students to compete to see which team can unroll the entire toilet paper roll while keeping the textbook balanced on top of it. At the end, the students are asked which component of the toilet paper roll was actually supporting the weight of the textbook. *Was it the tissue paper or the cardboard tube?* Then the analogy is explained. In this case, the tube is analogous to the metallic implant and the tissue paper is analogous to bone. As the students unraveled the toilet paper, they were like the osteoclasts degrading the bone (tissue paper) surrounding the implant (tube). This demonstration is used to reiterate the concepts of elasticity/stiffness, stress shielding, and bone remodeling by cells. Together these demonstrations reinforce the content by activating the different learning modes for the students and help to break up the tedium of lectured content.

Figure 2.

Stress shielding demonstration using a toilet paper roll and textbook. In the top left image, the *Biomaterials Science* textbook is supported by the full roll of toilet paper. In the top right image, the same textbook is supported only by the cardboard tube of the toilet paper roll. 7th grade student at PK Yonge Developmental Research School completing the demonstration.

The next part of the lesson is a design challenge activity. Students are asked to create a structure using only a single sheet of paper and Elmer's glue capable of supporting the weight of as many textbooks as possible on their desk. The only constraint for this activity is for the design to elevate the textbook an inch or more off of their desk. Students are free to cut, fold, and reshape the piece of paper in any way they see fit and to work individually or in teams (**Figure 3**). Students are encouraged to use the concepts they discussed throughout the beginning of the class in their designs namely those related to structure and composite materials. During this time, the teacher is able to go around the classroom and probe students as they formulate and build their designs. Throughout this period, students are able to quickly test their design and iterate on it using a new sheet of paper, if necessary. At the end of the activity, a brief classroom discussion is held to ask the students: *What designs worked? Which were crushed? Did your design use a composite material? How did you approach the challenge?*

Figure 3.

7th grade students at PK Yonge Developmental Research School testing their paper structures during the design challenge activity.

To conclude the lesson, students are assessed using the web-enabled quizzing platform, Kahoot! Students are able to access Kahoot! through a free cellphone application or web browser interface. If these resources are unavailable, the assessment can be administered by traditional means as a classroom poll or paper handout. The assessment consists of eight questions related to the content of the lesson. The Kahoot! platform allows the questions to be timed, giving students only 20-30 seconds to answer. After the timer a histogram of responses for each answer choice is displayed on the screen, at this time the teacher is able to address the class to reiterate concepts related to the question.

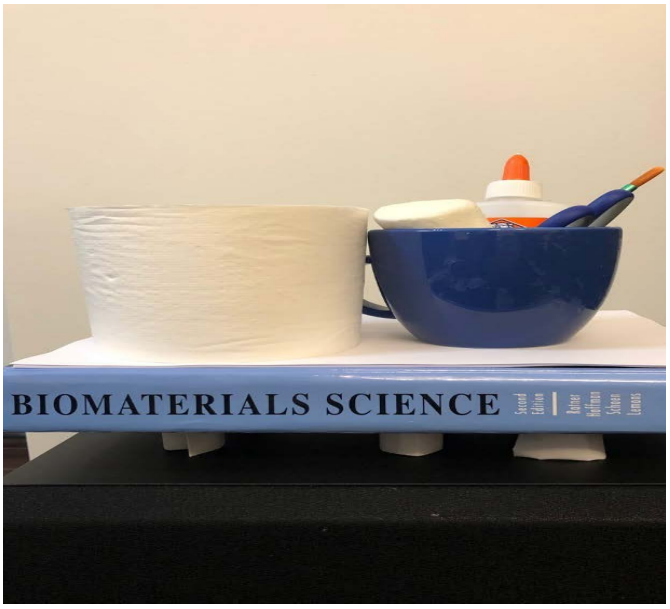
The Kahoot! quiz is available at the following link: https://create.kahoot.it/share/biomaterials-education-challenge/3148bbe6-dc36-4e60-b810-dcfdb4f13865

This lesson was designed from the ground up for inclusion in middle school science curriculums to address biomaterials concepts. To complete the lesson requires a minimum of supplies that are inexpensive and readily available (**Figure 4**).

Osseous biomaterials: When your bone needs help healing (continued)

The lesson has a capital cost of $45.61 after sales tax, which includes the initial purchase of paint brushes, scissors, glue containers, Elmer's glue, a ream of copy paper, and a bag of jumbo marshmallows. The last two items are considered capital costs because their typical retail quantity can be used across several lesson repetitions. The consumables for the lesson cost $8.00 after tax, which includes the purchase of a ceramic mug and toilet paper rolls. Costs are based on item sales prices as sold by Target and a Florida state sales tax of 7%. In conclusion, this is a very affordable and accessible lesson for implementation in middle school curricula.

Figure 4.



All of the materials necessary to complete the lesson's several demonstrations and design challenge activity.

ASSESSMENT METHOD AND RESULTS

To evaluate the effectiveness of the lesson, the development team partnered with Dr. Mayra Cordero, University School Assistant Professor and Instructor of Secondary Science, at the PK Yonge Developmental Research School at the University of Florida. Dr. Cordero says of the experience,

"This lesson gave my students insights into biomaterials at an early stage of their education. The lesson was inclusive and interactive as it included various activities to engage students in the learning about biomaterials, such as a short video, an online game, and hands-on activities. The students were motivated by the challenge of designing a model of a structure made out of biomaterials. The lesson also allowed my students to engage in the 21st century scientific and engineering practices that will prepare them for the workforce in the future."

The lesson was given to 104 7th grade students over 5 class periods (~20 per period). Content retention was assessed using the Kahoot platform and showed tremendous promise. Based on the compiled Kahoot results from the end of the lesson:

- 94% of students correctly identified that the composition, the structure, and the cells in bone contribute to its properties.
- 86% of students correctly identified that bone is a living, lightweight, strong material.
- 79% of students recalled that bone is a composite material.
- 61% of students correctly identified that stiffness is related to bending. 29% of students incorrectly identified that stiffness is related to fracture.
- Only 36% of students correctly identified that elasticity/stiffness is related to stress shielding. 22% incorrectly associated it to strength and 28% incorrectly associated it to fracture.

The assessment indicated that students were able to grasp the content related to bone; however, they had much more difficulty retaining the materials science content. We attribute this to the instruction in terms of guiding students to discriminate the difference between strength and stiffness. To rectify this, we intend to make sure to explicitly stress their difference. We also attribute this to the difference in language commonly used in daily life and by materials engineers; as these nuanced definitions can be challenging even for undergraduate students. On the other hand, students readily identified differences in properties between material types when asked about them abstractly. For instance, during the background instruction on bone, students were asked, "What if your bones were only made of ceramic?" They answered by saying that our bones would break much more readily. And then when asked, "What if our bones were only made of materials similar to marshmallows?" The class answered by saying that our bones would not be able to support our weight. This observation makes us hopeful much of the materials science content is being understood. From the group discussion held after the design challenge activity, students independently recognized that short, wide posts were better at supporting the load of the textbook as compared to long, skinny posts. Likewise, they identified that glue reinforced the paper after it dried resulted in a stiff composite material. At the beginning of the lesson, students were unaware of biomaterials; however, by the end students were interested in learning more about other types of biomaterials such as those related to cartilage or to the cardiovascular system. Most importantly, the students showed great interest and excitement to further learn about biomaterials!

REFERENCES

1. NGSS Lead States, *Next Generation Science Standards: For States, By States*, Washington, DC: The National Academies Press, 2013.

The Cato T. Laurencin Travel Fellowship

The Cato T. Laurencin Travel Fellowship supports 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 membership in the Society. The goal of this fellowship is to stimulate and encourage recipients to pursue a career in biomaterials.

KAI ADEBI CLARKE
Florida Institute of Technology

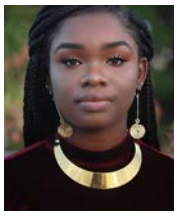
SYDNEY WIMBERLEY
University of Connecticut

TO APPLY FOR THIS TRAVEL FELLOWSHIP

for the 2020 World Biomaterials Congress in Glasgow, Scotland (May 19-24, 2020), please submit an application by ***NOVEMBER 29, 2019***.

REFLECTIONS

BY STUDENT WINNERS



By Kai Clarke, Florida Institute of Technology

Monumental. That sums up my experience in Seattle, Washington, while attending the national Society For Biomaterials conference. As an international student, I welcomed this opportunity to access work from some of the top researchers in my field as well as meet students and professors of various backgrounds who are passionate about the field as I am. I was encouraged to apply for the Cato T. Laurencin Travel Fellowship by my mentor in the lab, who actually met Dr. Laurencin at the 2018 SFB conference. The fellowship enabled me to attend my first professional conference. Throughout the conference, I was engulfed by the many different branches of science and engineering that use biomaterials, some of which were completely foreign to me. Being able to attend the presentations as well as speak one on one with the presenters were such breathtaking experiences. I was extremely nervous to present my poster as a mere undergraduate, but the welcoming faces and encouraging comments by professors, researchers and students alike made the experience unforgettable. I am forever indebted to Dr. Laurencin and the selection committee for giving me this immense opportunity: It has exposed me to the vast world of biomaterials and their applications and opened my eyes to the many opportunities waiting for international and minority students such as myself.

By Sydney Wimberley, University of Connecticut

Before I entered college, I had never heard of biomaterials. My introduction to the field was through a summer program in the same department as Dr. Laurencin at the University of Connecticut. This summer opportunity gave me the chance to narrow down what I wanted to do in college and beyond. This fall, I learned that Dr. Laurencin was offering a travel scholarship for the Society For Biomaterials conference. In spring 2019, I had the chance to attend. During the conference, I was exposed to an overwhelming variety of topics that I previously had not known existed. Also, I had the chance to network with leaders in field of diverse backgrounds and experiences. I am thankful to Dr. Laurencin and SFB for awarding me this travel scholarship: This conference provided me with information that I will use in determining next steps in my educational endeavors. I am excited about my future studies in this field because it offers possibilities beyond what I thought was available.

Industry News

By Steve Lin, Industry News Editor

Boston Scientific (Marlborough, Massachusetts) **announced its definitive agreement to acquire Vertiflex,** developer of the Superion Indirect Decompression System, by late 2Q19. This is a transaction of $465 million in cash plus contingency payments based on commercial milestones over three years. The Superion device is expected to achieve $60 million in 2019 revenue. Superion creates space between the spinous processes of the vertebrae to improve function and reduce pain in lumbar spinal stenosis patients. Vertiflex was founded in 2005 and has, over the years, sold certain of its assets to Exactech and Stryker. The company is based in Carlsbad, California.

Medtronic (Dublin, Ireland) announced its definitive agreement to acquire Titan Spine, provider of titanium spine interbody implant and nanoLock surface enhancement technology. The last time Titan Spine publicly disclosed annual revenue, it was $33.5 million in 2015. Various sources suggest that its annual revenue reached $63 million in 2017. Titan was founded in 2005 by a former surgeon, Dr. Peter Ullrich, and has reportedly raised over $50 million in funding. Headquarters are based in Mequon, Wisconsin, and an overseas facility operates in Laichingen, Germany. Medtronic believes that its biologics paired with Titan's nanoLock surface-enhanced devices can positively impact patient outcomes. Medtronic could use the biologics pull-through from these devices, as biologics growth has decelerated over the last eight quarters. They grew 2.9 percent in 2018 after growing 4.4 percent in 2017.

Glaukos Corporation (San Clemente, California), an ophthalmic medical technology and pharmaceutical company focused on the development and commercialization of novel ophthalmic surgical devices and sustained pharmaceutical therapies, announced that it has successfully completed the acquisition of DOSE Medical Corporation that was previously announced on June 19, 2019. With the transaction's completion, DOSE Medical has now become a wholly owned subsidiary of Glaukos. DOSE Medical is developing multiple micro-invasive, bioerodible, sustained-release drug delivery platforms designed to be used in the treatment of various retinal diseases, including age-related macular degeneration and diabetic macular edema.

AbbVie Inc. (Chicago, Illinois) agreed to pay $63 billion for rival drugmaker **Allergan Plc** (Dublin, Ireland). The price tag caused heartburn on Wall Street, and AbbVie had its worst day of trading since it was spun off from former parent Abbott Laboratories. AbbVie will pay $188.24 a share in cash and stock, a 45 percent premium. The proposed takeover doesn't give AbbVie a pipeline full of potential blockbuster drugs, but it buys the company time to develop more. Allergan provides AbbVie with a set of products big enough to diversify its revenue from Humira, the rheumatoid arthritis injection that is the world's biggest-selling drug worldwide, with about $20 billion in sales last year. Allergan, which is heavily reliant on the wrinkle reducer Botox, will get a profitable exit for shareholders after a four-year slide.

Canady Life Sciences, Inc. (Takoma Park, Maryland), which consolidates US Medical Innovations, LLC and US Patent Innovations, LLC under its corporate umbrella, announced the acquisition of the French robotic company Endocontrol (La Tronche, France). Endocontrol was founded in 2006 and designs, manufactures and markets robotic-assisted solutions for mini-invasive and laparoscopic surgery. The company offers a motorized robotic endoscopic positioner for laparoscopy via voice or foot control and an ultra-compact motorized uterus positioner for gynecologic surgery (VIKY system). In addition, Endocontrol has developed a 5mm motorized articulated surgery instrument and needle holder that gives access to intra-abdominal areas (JAIMY system). The Endocontrol robotic technology is protected by 10 patents and various trademarks. The company has sold over 200 robots worldwide.

Vascular Perfusion Solutions (San Antonio, Texas) has developed ULiSSES, a first-of-its-kind medical device to preserve and resuscitate vascularized tissue — organs and limbs — for more than 24 hours. More than 20 people die every day due to the lack of available organs for transplant, according to the American Transplant Foundation. Per the Organ Donation and Transplantation Alliance, donated organs have an extremely short shelf life. More than 50 percent of all donated organs fail to reach transplant patients in time and are thus rejected. When it comes to specific organs, the rejection numbers jump significantly, with more than 70 percent of hearts and 80 percent of lungs unable to be transported in time. ULiSSES technology is licensed by the University of Texas Health Science Center at San Antonio.

According to **Technavio research report "Global Medical Devices Market 2018 – 2022,"** the medical devices market by product (therapeutic and surgical devices, patient monitoring, diagnostics, and medical imaging devices) and geographical region (APAC, EMEA and the Americas) is expected to grow $119.98 billion at a CAGR of 5 percent during 2018 to 2022. The medical device market has been growing rapidly in emerging

Industry News (continued)

countries. By 2022, more than 30 percent of the global healthcare expenditure is expected to arise from emerging economies. The medical devices market in emerging economies offers opportunities due to significantly high operating margins across the various industry subsectors. This is primarily due to the large, growing and increasingly wealthy middle class willing to pay for high-quality medical services that governments have not managed to deliver in the past.

Advances in internet-connected consumer medical devices are improving patient outcomes and lowering costs, according to a recent article published in JAMA. It is estimated that more than 50 million people in the United States currently wear a connected device to track activity, and that number is expected to increase to more than 160 million over the next few years. Companies are adding an increasing number of features to their devices, such as electrocardiographic and fall-detection capabilities. Interestingly, popularity for wearable devices is highest amongst those over age 55 and is also growing fastest amongst this age group, according to a recent **eMarketer report**. According to its research, the over 55 age group represents just over 30 percent of the total wearable device market. In 2019, it is predicted that 8.2 million Americans aged 55 and older will use a wearable device, up more than 15 percent from 2018.

HAVE A ***LETTER TO THE EDITOR, BOOK RECOMMENDATION*** OR ***COVER ART*** TO SHARE WITH FORUM READERS?

PLEASE CONTACT
Guigen Zhang at guigen.bme@uky.edu.

Government News

NATIONAL ACADEMIES' FORUM ON REGENERATIVE MEDICINE

By Carl Simon, Government News Editor

The National Academies' Forum on Regenerative Medicine[1] provides a mechanism for stakeholders in the field to discuss key issues. The Forum was established in 2016 and consists of approximately 35 experts from academia, industry, government, patient groups, foundations, associations and societies. Forum members meet several times each year to identify focus areas to illuminate via workshops, proceedings and perspective papers. Over the past several years, three workshops have been organized; they have focused on challenges for cellular therapies,[2] regenerative medicine product manufacturing,[3] and variability in regenerative medicine products.[4] Detailed proceedings from these events are available online for free in pdf format. In addition, a perspective paper on manufacturing is available.[5] The next workshop will be at the National Academies in Washington, DC, on November 19, 2019, and is entitled "Exploring Novel Clinical Trial Designs for Gene-Based Therapies."

REFERENCES:

1. Forum on Regenerative Medicine. The National Academies of Sciences, Engineering, and Medicine Web site. http://www.nationalacademies.org/hmd/Activities/Research/RegenerativeMedicine.aspx. Updated December 18, 2018. Accessed August 7, 2019.
2. National Academies of Sciences, Engineering, and Medicine. Exploring the state of the science in the field of regenerative medicine: challenges of and opportunities for cellular therapies: proceedings of a workshop. https://www.nap.edu/catalog/24671/exploring-the-state-of-the-science-in-the-field-of-regenerative-medicine. Published 2017. Accessed August 8, 2019.
3. National Academies of Sciences, Engineering, and Medicine. Navigating the manufacturing process and ensuring the quality of regenerative medicine therapies: proceedings of a workshop. https://www.nap.edu/catalog/24913/navigating-the-manufacturing-process-and-ensuring-the-quality-of-regenerative-medicine-therapies. Published 2017. Accessed August 8, 2019.
4. National Academies of Sciences, Engineering, and Medicine. Exploring sources of variability related to the clinical translation of regenerative engineering products: proceedings of a workshop. https://www.nap.edu/catalog/25371/exploring-sources-of-variability-related-to-the-clinical-translation-of-regenerative-engineering-products. Published 2019. Accessed August 8, 2019.
5. Haddock R, Lin-Gibson S, Lumelsky N, et al. Manufacturing cell therapies: the paradigm shift in health care of this century. *NAM Perspectives*. Published online: June 23, 2017 (doi:10.31478/201706c).

A Reflection from the Conference on Bacteria–Material Interactions

DIVERSE EXPERTS ADDRESS MEDICAL IMPLANT INFECTION CHALLENGES

By Matt Libera, Stevens Institute of Technology

Infection associated with tissue-contacting biomedical devices is a compelling clinical problem. All implanted biomaterials increase host infection risks for the lifetime of the implant. These include joint prostheses, heart valves, neural shunts or advanced tissue-engineering scaffolds, among many others. All are more susceptible to microbial colonization than native tissue. Microbial colonies frequently develop into antimicrobial-resistant biofilms that promote chronic infection of the surrounding tissue, an infection that most often can only be resolved by implant removal followed by extensive antimicrobial treatment and costly revision surgeries. The impact of biomaterials-associated infection — or, more generally, implant infection — on both the patient and on the healthcare system can be substantial. Historically, biomaterials chemistry, morphology and pairing strategies with diverse active antimicrobial agents have all attempted to address this biofilm infection challenge without sufficient clinical satisfaction.

The 5th Stevens Conference on Bacteria–Material Interactions,[1] held on June 12 and 13, 2019, on the campus of the Stevens Institute of Technology in Hoboken, New Jersey, focused on this problem of implant infection and biofilms. The conference assembled a cross-disciplinary group of clinicians, academicians, industrial scientists and engineers, and regulatory scientists from around the world to discuss key challenges and the most recent research findings associated with the design, development and use of infection-resisting biomaterials. Of the over 100 attendees, many were members of the Society For Biomaterials.

A Reflection from the Conference on Bacteria–Material Interactions (continued)

Centering on long-standing challenges, the conference featured a session dedicated to clinical aspects. Dr. Javad Parvizi of the Rothman Orthopaedic Institute in Philadelphia, Pennsylvania, addressed the increasing problem of periprosthetic joint infection (PJI). He described PJI as a "massive" problem from the patient's perspective and perhaps the most difficult and challenging complication next to death itself. He further noted that the five-year mortality rate of PJI is comparable to that of many common cancers (e.g., breast cancer and prostate cancer). Dr. Jerry Zuckerman (Hackensack Meridian Health, Edison, New Jersey) discussed the infection problem from the perspective of hospitals, where infection control is a key operational concern with recognized implications for patients, for reimbursement by insurance providers and for the reputation of a hospital system. Dr. Celeste Abjornson (Hospital for Special Surgery, New York, New York) made the clear point, however, that the surgical environment is not the only source of microbial contamination of a tissue-contacting device. Host, biomaterial and perisurgical (including postsurgical) factors must be considered in a systems approach to the problem. She discussed so-called occult infection of the spine and argued that many infections of spinal hardware come from bacteria inherently present in the local tissue or even in patient intervertebral discs.

Invited presentations described ongoing research efforts to find biomaterials solutions to the implant-infection problem, addressing such topics as antimicrobial peptides and peptoids, identification of critical intervention points during colonization to prevent biofilm development, the effect of nano- and microsurface topography on bacterial adhesion, and self-defensive surfaces that release antimicrobials in response to bacterial triggers. The conference was bracketed by an opening talk defining the state of the field (David Grainger, University of Utah, Salt Lake City, Utah) and a closing talk outlining the future of the field (Henny van der Mei, University Medical Center, Groningen, Netherlands). A lively hour-long panel discussion assessed how far the field has come, fundamental barriers and how far it now must go. A clear consensus emerged that development of clinically acceptable solutions must face the stark challenges presented across the many different stakeholders involved: clinicians, basic and translational biomaterials scientists, device industries, regulatory bodies, and health providers and insurers. To solve this clinical issue, all must agree on language and test methods to create materials, devices and approaches for implanting medical devices that can simultaneously promote healing while inhibiting infection.

In addition to 14 invited lecture presentations, over 40 poster presentations were contributed. The conference featured two dedicated poster sessions for scientific exchange and networking. The overall high quality of these posters challenged a panel of four judges to identify the top three prize winners. These three were each recognized at the conference's closing session: Nathalie Karaky from Manchester Metropolitan University (*Antimicrobial Activity of Metals & Graphene Derivatives Against Multi-Drug-Resistant* Klebsiella pneumoniae*)*, Carly Deusenbery from Brown University (*Utilizing IDR-1018 to Develop Antibiofilm Gellan Hydrogels)* and Dr. Hao Wang from the U.S. Food and Drug Administration (*An Ex Vivo Model of Medical Device-Mediated Bacterial Skin Translocation)*.

The Stevens Conference on Bacteria–Material Interactions series is orchestrated by SFB member Prof. Matthew Libera (Stevens Institutes of Technology, Hoboken, New Jersey). The forum has been held every other June starting in 2011. The 5th Stevens Conference was supported by contributions from NSF, NIH NIBIB, Orthobond, MTF Biologics, Stryker Orthopaedics and Zimmer Biomet. The 6th Stevens Conference will be held in June 2021.

The panel discussion at the 5th Stevens Conference involved (left to right) Dr. Scott Phillips (U.S. Food and Drug Administration), Dr. Imran Khan (Zimmer Biomet), Dr. Paul Stoodley (The Ohio State University) and Dr. Javad Parvizi (the Rothman Orthopaedic Institute).

REFERENCE:

1. The 5th Stevens Conference on Bacteria–Material Interactions. Stevens Institute of Technology Web site. www.stevens.edu/biomaterials2019. Accessed August 8, 2019.

Meet the Rising Stars

Notes from the Editor: *Here is an interview with* SFB's 2019 Young Investigator Award winner Stephanie Seidlits, *assistant professor in the Department of Bioengineering at the University of California, Los Angeles (UCLA). Dr. Seidlits' research seeks to engineer biomaterial-based models of central nervous system (CNS) tissues, use these models to understand how microenvironmental cues regulate tissue function, and apply this knowledge to the development of new clinical treatments, in particular for spinal cord injury repair and brain cancers. Prior to joining UCLA, Dr. Seidlits received her PhD in biomedical engineering from the University of Texas at Austin as a joint advisee of Prof. Christine Schmidt and Prof. Jason Shear. She then completed a postdoctoral fellowship in the laboratories of Prof. Lonnie Shea at Northwestern University.*

Among the most recent awards that Dr. Seidlits received in recognition of her innovation are an NSF CAREER Award, an NIH R21 Award, an American Brain Tumor Association Discovery Grant, a UCLA Hellman Fellows Award, a University of California Cancer Research Coordinating Committee Research Award, a UCLA Broad Stem Cell Research Center and California NanoSystems Institute Stem Cell Nano-Medicine Initiative Planning Award, UCLA Broad Stem Cell Research Center Innovation Award, and the 2019 SFB Young Investigator Award.

GZ: First of all, I want to congratulate you again for receiving the SFB Young Investigator Award, as well as many other awards. I would like to start by asking: When did you become interested in biomaterials research?
SS: Thank you. I am honored to be the recipient of such a prestigious award. I was first exposed to biomaterials research as an undergraduate student in bioengineering at Rice University, where I had the opportunity to learn a lot through both my classes and my time as a research assistant in Prof. Tony Mikos' lab. During my studies, I became particularly intrigued by the role of the extracellular matrix as an essential regulator in cell and tissue function. Biomaterials seemed like the perfect tool to study the matrix as they can be engineered to mimic many of its key features and applied externally to living cells or tissues to evaluate their responses. I study the brain and spinal cord. There are still many questions about the mechanisms underlying the basic functions of these tissues and how these go wrong in cases of injury or disease. Biomaterials provide unique tools that can be used to study these pathologies while simultaneously developing clinically translatable therapies.

GZ: Would you give some brief highlights of your research work? What impact you would like to make in terms of helping people and improving quality of life?
SS: At the interface of engineering, neuroscience and medicine, I work to develop biomaterials that mimic the extracellular matrix of CNS tissues. I aim to use these biomaterials as scaffolds that can interface with the CNS to direct cell behavior and facilitate tissue repair after injury. In addition, my research is developing these biomaterials as preclinical models of brain tumors that can be used for personalized medicine. For both applications, biomaterials enable us to untangle effects of the complex factors in the microenvironment so we can really start to nail down the specific factors that may lead to clinically actionable treatments. To do this, my lab uses a vertically integrated approach, where the same biomaterials can be used to make discoveries in simplified, controlled settings in vitro, and these findings verified in more complex settings in vivo using the same biomaterials. By repeating this process, we can iteratively refine both in vitro models and therapeutic approaches. Ultimately, I expect this multidisciplinary approach to speed up the development of much-needed therapies for CNS injury and disease.

"MY APPROACH TO BIOMEDICAL RESEARCH IS TO GAIN A DEEP UNDERSTANDING OF THE CLINICAL PROBLEMS FROM THE BEGINNING, THEN DEVELOP THE TECHNOLOGY NEEDED TO ADDRESS THESE PROBLEMS. TO DO THIS, I LIKE TO BEGIN ANY PROJECT BY CONSULTING WITH A NUMBER OF EXPERTS WHO CAN PROVIDE MANY DIFFERENT PERSPECTIVES."

GZ: How big is your research group? What can you share with our readers about how you run your group and motivate your students or postdocs? What are the challenges and the rewards?
SS: Currently, my research group is composed of about four PhD and undergraduate student members (Figure 1). They are from diverse academic backgrounds, including bioengineering, chemical engineering, chemistry, neuroscience and molecular biology, which is a distinct advantage when pursuing highly interdisciplinary work. I try to foster a supportive lab culture that focuses on teamwork. Research is filled with challenges, and I believe that the collective of all of our ideas and efforts will lead to not only the best scientific products but our continual growth and evolution as conscientious scientists. I am incredibly lucky

Meet the Rising Stars (continued)

to have the chance to work with such talented and dedicated individuals at UCLA and have found watching their growth as scientists and engineers to be extremely rewarding.

GZ: You are very successful in securing research funding from highly competitive sources, such as NIH and NSF. In your opinion, what are the keys to such successes?
SS: Although I began actively participating in grant writing as a graduate student, I am still continually learning and refining my skills. For myself, I have found the most challenging skill to perfect is the art of distilling complex ideas into succinct text that is clear (and exciting!) to readers with a range of scientific interests. This requires me to block out time on my calendar not only for "writing" per se but also actively thinking about the significance of the problem and really drilling down to how my approach can uniquely tackle the problem in an impactful way. This also means that I write many, many drafts! My biggest piece of advice is don't be afraid to share your early drafts with colleagues at different stages of their careers and with different backgrounds. Then, don't be afraid to completely start over and rewrite your proposal based on their feedback. Remember that crafting a competitive grant is a process!

GZ: What can you share with our readers in terms of the **do's** and **don'ts** in research program development, proposal writing, etc.?
SS: Core values to all of the work that we do as academics include scientific integrity and public service. When experiments don't work out the way you expect or rejections mount, be patient, tap into your creativity and trust that you will persevere. Don't let the pressures compromise your scientific integrity or vision. Remember that we are all working toward the same altruistic goal of advancing scientific knowledge to improve options for medical treatment — ultimately helping people and society! Do remember to be a conscientious and respectful collaborator, mentor, teacher and contributor to the scientific community.

GZ: To date, you have published about 30 papers and received some 15 grants. What percentage of your time is spent on writing papers or proposals?
SS: It's at least 50 percent of my time. However, what I am working on, as far as grant or paper and the subject matter, changes constantly depending on the needs of lab.

GZ: A successful young researcher often gives people the impression that work is all of your life. You seem to be doing extremely well balancing work and life by also being a mother of a toddler. How do you do it? Can you share with our readers something about your son and your family life?
SS: I am lucky to have a supportive family, so that I am not doing everything alone! While it is a continual challenge to work toward a balance, I have observed many faculty members with children be successful, which gives me confidence that it is possible. I have picked up tips from a variety of sources to incorporate into a strategy that is personalized for my family. For

Dr. Seidlits with her lab members as of December 2018.

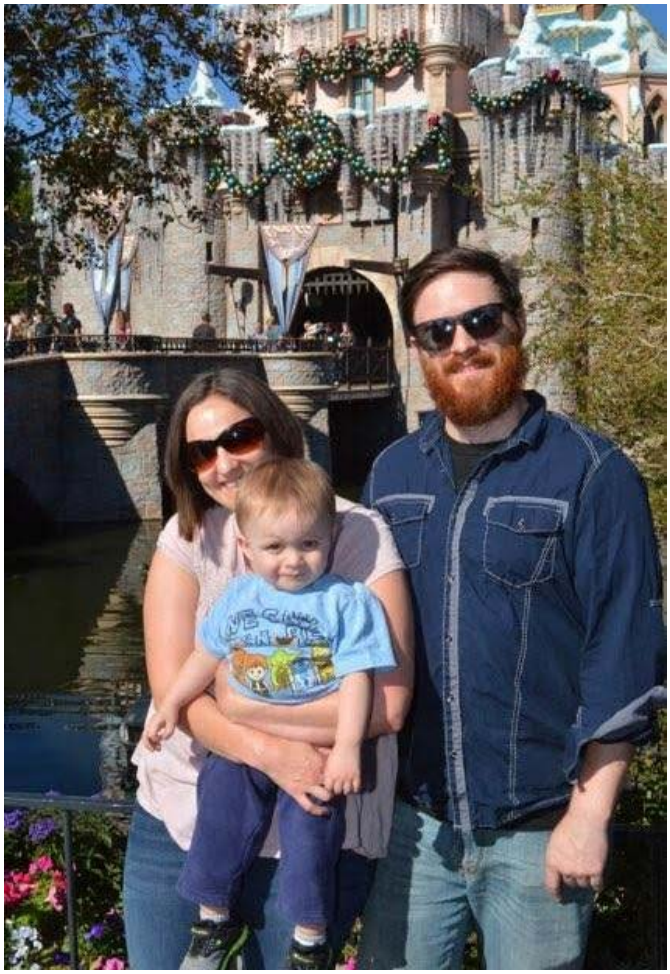
Meet the Rising Stars (continued)

example, while academic research is a lot of work, it also has a lot of flexibility about when that work can be done. This means that, for example, my husband and I can alternate afternoons off of work to spend with our son and make up the work hours at night or on the weekends. My son recently turned 2 and will be starting preschool full-time in the fall, so we will be moving into a new stage to navigate soon. As my son grows up, I expect my role as parent and the challenges of balancing this role with my job to be constantly evolving, but this will keep life exciting!

GZ: Looking ahead, what challenges do you see in realizing the impact you would like to make through your innovative research work?
SS: I believe my lab's focus on engineering new tools for intimate interfacing with brain and spinal cord tissue in a way that takes advantage of the inherent biology has high potential for clinical impact. However, translation will require extensive interdisciplinary collaborations to integrate these tools into standard and cutting-edge clinical strategies. I am currently working with a number of collaborators, including clinician scientists, engineers, chemists, neuroscientists and pharmacologists, to secure funding for and perform the preclinical studies required to advance these technologies closer to clinical translation.

GZ: You mentioned several times the need to collaborate and work with the right partners and clinician scientists. How do you identify the right ones?
SS: My approach to biomedical research is to gain a deep understanding of the clinical problems from the beginning, then develop the technology needed to address these problems. To do this, I like to begin any project by consulting with a number of experts who can provide many different perspectives. From these perspectives, I am able to refine my own ideas, identify the first steps and design a strategy that is most likely to lead to succeed. These interactions also give me the opportunity to identify who might make a good collaborator. I look for people who share my research goals and priorities and can contribute an otherwise "missing piece" to the work. In my experience, collaborations are most productive when they are truly partnerships and both parties are invested in all stages of the work.

GZ: What thoughts you could share with aspiring women students and postdocs in the biomedical engineering fields?
SS: My advice is to have confidence in your own ideas and abilities. While it is definitely advantageous to take into account constructive criticism about your research and helpful advice from others about your career path, ultimately you have to trust yourself and do what you think is best.



Dr. Seidlits with her husband, Shea, and son, Eliot, at Disneyland in November 2018.

DECEMBER 11–13, 2020

ON WAIKIKI BEACH • HONOLULU, HAWAII

www.Biomaterials.org

The Society For Biomaterials (US) and the Japanese Society for Biomaterials are hosting a joint symposium that will highlight the seminal work of four pioneers in the biomaterials field! The three-day program will feature addresses by our honorees and other sessions of interest in their respective areas of expertise:

James M. Anderson, MD, PhD
Case Western Reserve University
Implant Pathology and the Foreign Body Reaction

Art Coury, PhD
Northeastern University
Biomaterials Evolution: Commercial to "Designer" Polymers — A 50 Year Perspective

Tadashi Kokubo, PhD
Kyoto University *and*
Chubu University
Driving Force for Promoting Innovation of Biomaterials: from Bioglass to Bioactive Metals

Teruo Okano, PhD
Tokyo Women's Medical University
and the ***University of Utah***
Design of Intelligent Surfaces for Cell Sheet Tissue Engineering

Society For Biomaterials

JAPANESE SOCIETY FOR BIOMATERIALS