HISTORICAL FLASHBACK BY HOWARD WINET

# BIOMATERIALS FORUM

OFFICIAL NEWSLETTER OF THE SOCIETY FOR BIOMATERIALS

FOURTH QUARTER 2017 • VOLUME 39, ISSUE 4

## BREAKING NEWS:

MICHAEL SEFTON AND MOLLY SHOICHET APPOINTED TO THE ORDER OF CANADA, THE CANADIAN EQUIVALENT OF UK'S KNIGHTHOOD. CONGRATULATIONS SIR MICHAEL SEFTON AND DAME MOLLY SHOICHET!

## ALSO INSIDE

*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.



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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.



BIOMATERIALS FORUM

The official news magazine of the **SOCIETY FOR BIOMATERIALS** • Volume 39, Issue 4



## SPECIAL INTEREST GROUP REPORTERS

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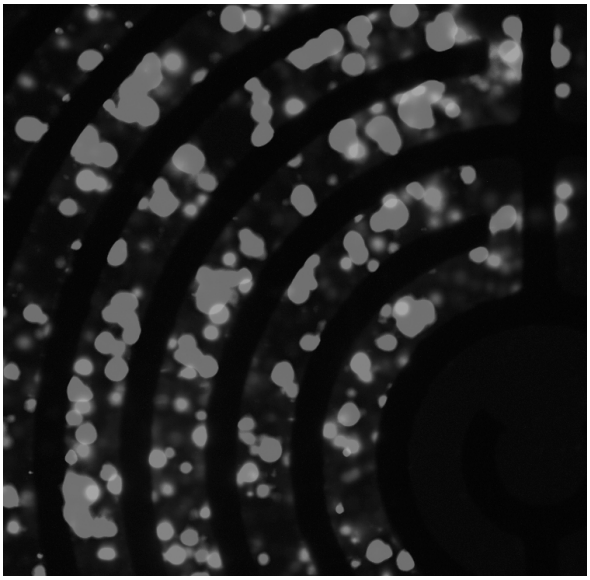
## THE TORCH



## NEWS & UPDATES





## ON THE COVER

The cover image, provided by Yu Zhao of the research group of Prof. Guigen Zhang at Clemson University, shows an optical image of captured cells (red cells are normal breast cells, and green cells are cancerous breast cells) with dielectrophoretic (DEP) forces generated from concentric electrodes biased under an alternating current (AC) at 1MHz. The group is exploring this DEP technique for quickly aligning cells into a desired pattern with a flip of a switch and then separating normal and cancerous cells by tuning the AC frequency.

# From the Editor

*Guigen Zhang*

Hi, y'all, from Lexington, the horse capital of the world, where the University of Kentucky resides! In case you have not heard, I just moved from Clemson to UK (UK for the University of Kentucky, as people here call it; not the United Kingdom, mind you!) to become the F. Joseph Halcomb, III, MD Endowed Chair, Professor and Chair of the F. Joseph Halcomb, III, MD Department of Biomedical Engineering (BME).

"Who is Joseph Halcomb, III, MD, the benefactor?" you may wonder. A short answer: He is an early trainee of the biomedical engineering program at UK. A long answer: Dr. Halcomb is a known leader in the biomedical engineering community. After joining Zimmer in 1980, he rose quickly to vice president for product development for the Orthopedic Implant Division. He became senior vice president of operations in 1990 and later president of Zimmer's Hall Surgical Division, the world's leading supplier of powered surgical instruments. In 1995, he joined Amgen to build a venture in cell therapy, and in 2006, he became vice president, leading drug product and device development for the $16 billion global human therapeutics company. He is a partner with Telegraph Hill Partners, a venture capital firm that helps life science, medical device and healthcare companies achieve their growth objectives, and founder of Phoenix Initiãre, a private equity firm dedicated to helping startups.

While the limited space here won't allow me to express my deep gratitude, I do want to highlight some of what he said when reflecting on the impact the two giants, James F. Lafferty and Charles F. Knapp, made in nurturing his interest in combining engineering and medicine: "Faculty members should never let go of the possibility that they are making a tremendous impact on their students. They didn't know it at the time, but they were speaking on my frequency," and, "What I want to see more than anything else is that students in the biomedical engineering program make a difference in patients' lives."

Why I am telling you this? Well, in my From the Editor article in the last issue, I left you with an unanswered question: What constitutes a culture? I found the answer in Dr. Halcomb's words.

Not following me? In Thomas Friedman's 2017 book, *Thank You for Being Late: An Optimist's Guide to Thriving in the Age of Accelerations*, he describes a Gallup poll "conducted of college graduates who had been in the workplace for at least five years trying to answer this question: What are the things that happen at a college or technical school that, more than anything else, produce engaged employees on a fulfilling career track?" Friedman explained that the poll found "no difference in terms of type of institution you went to — public, private, selective or not — in long-term outcomes. How you got your college education mattered most" and that "successful students had one or more teachers who were mentors and took a real interest in their aspirations …, who encouraged their goals and dreams …, who cared about them as a person."

A person, not a number! The culture in sports seems to work the same way. For example, the Houston Astros have been known to be the industry's most analytically driven organization, relying almost entirely on data assembled by in-house talent from the worlds of economics, physics and engineering. But this analytical system made every player a number instead of a person. The willingness by Astros' management to embrace the value of chemistry and culture paid enormous dividends in 2017: The Astros won the World Series, the team's first since the franchise's creation in 1962.

The take-home message: When it comes to building culture, chemistry seems to matter more than engineering! Don't just count beans; treat every member as a person.

In closing, let me briefly tell you what we have prepared for you in this issue. Aside from hearing from the president and reading member, staff and student news, you will get caught up with updates from the Biomaterials and Medical Products Commercialization and Biomaterial–Tissue Interaction SIGs. In our regular columns, you will read industry news, government news and education news, as well as a book review. In the Historical Flashback column, you will read an interesting and humorous perspective of SFB history by Howard Winet. Lastly, I would like to draw your attention to the column of Letter to the Editor in which Elaine Duncan, an SFB pioneer and past executive editor of the *Biomaterials Forum* shares her viewpoints in her letter. With this column, I extend my sincere invitation to all members to share your viewpoints with us.

Best wishes,

Guigen Zhang

# From the President

*David Kohn*

The Nexus of Research and Application
As we kick off the new year, and look forward to the SFB Annual Meeting, the theme of my third letter, is about connections. I borrowed the title of this letter from the theme for our annual meeting, but to me the Society is more than the nexus of research and application. It's industry and academia, it's the lab and the clinic, it's in the professional relationships and personal friendships that grow from participating and engaging in such a close-knit, passionate community of scientists.

Since my last communication, the SFB Council met and agreed to its 2018 budget. Our fiduciary commitment to the Society's long term fiscal viability rendered the need for a modest increase to the cost of membership ($5 increase in membership dues + $5 increase in SIG dues). The increase will continue SFB's ongoing connections for dissemination of ground-breaking industrial, academic and government research, Special Interest Group collaborations, as well as networking opportunities within all spectrums of membership.

As a member for over 30 years, the Society has helped me to stay connected and grow professionally and personally. I invite you to take a look at the video we recently posted to the SFB Facebook where most of our current Council shared their views on what makes SFB so special and to "join us" as we strive to broaden our membership.

I also welcome you to take a look at the Program for the 2018 Annual Meeting (which should be online at 2018.biomaterials.org by the time this newsletter is published). You'll notice topics ranging from efforts to commercialize regenerative technology to implantable bioelectronics. The breadth of our Society is staggering. To help members navigate the meeting, we have again set up a Biotechnology in Industry track (BTI) and, this year, we instituted a career catalysis track to provide guidance to students and young members on career opportunities in biomaterials. The breadth of scientific pursuit and connection to other scientists, engineers and clinicians at our meeting still inspires me to explore ideas outside of my field and I continue to enjoy meeting the people that are doing this amazing work. Hearing cutting-edge science from colleagues at every career stage and every corner of the world is a reminder of our organization's unique ability to convene the people and perspectives needed to solve the most pressing biomaterials challenges of our time. I am looking forward once again to seeing and hearing the breadth and depth of research and varying viewpoints. Recurring in 2018, the posters will be an integral part of the annual meeting. The high quality of the abstracts this year led the Program Committee to develop rapid fire sessions, in which 120 poster presenters will have the opportunity to also give brief talks on their work. Late-breaking abstracts may be submitted on line at 2018.biomaterials.org until midnight ET on February 1, 2018.

Putting together the annual meeting presents both opportunities and challenges. Opportunities for new learning and collaboration, and challenges in the logistics of suitable accommodations. In the past few years, we have waffled between hotels and convention centers to accommodate our need for a large amount of space, but this comes at a cost. We must make commitments to our host hotels in determining the appropriate room blocks so that we can secure the needed meeting space. As such, we need your help in ensuring that we actually sell all the rooms in our block. When we fail to achieve this, we are penalized with attrition payments that can be substantial, and can greatly impact the cost of meeting registration.

As you can see, the plans for the 2018 Annual Meeting are well underway and we look forward to seeing you there. To stay more connected at the annual meeting we encourage you to make room reservations at the host hotel found at **https://2018.biomaterials.org/hotel-information**.

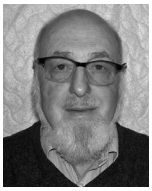
I look forward to a very productive year ahead, and encourage you to grow your connections to the Society by increasing your personal involvement with the Society's SIGs, Committees and Task Forces. If you are interested in volunteer service, please contact our headquarters offices at **info@biomaterials.org**.

Happy New Year!
Dave

# Historical Flashback

## FROM "DUKE OF CONFRONT" TO "DUCHESS OF INCLUSION" AND ALL INBETWEEN

*By Howard Winet*



In 1988, I met Jeffrey Hollinger in San Diego at a Bone Symposium. His talk convinced me to enter the field of biomaterials. Under his guidance, I embarked on a road to understanding how polylactide-polyglycolide interacts with healing bone tissue as it hydrolyzes. As expected, I have come nowhere near the end of that road. But, along the way I have met quality scientists and truth professionals (physicians, dentists, engineers and entrepreneurs) who have made me deeply thankful for that 1988 meeting and my ensuing friendship with Jeff.

It wasn't until 1993 that I expanded my circle of biomaterial colleagues beyond orthopaedic biomechanicists and the small circle of biomaterials scientists I met at Walter Reed while completing a National Academy of Sciences Research Associateship with Jeff. That year I joined the Society For Biomaterials. I had spent some 12 years learning to work with physicians and engineers after leaving biofluid dynamics research in 1980, so they provided me with no great surprises at SFB Annual Meetings.

Members from industry provided the great surprise. I was still a boffin, having been stashed away in academic white towers, coating myself with intellectual snobbery and avoiding any connection with those "materialistic worshippers of profit who could not be bothered with rigorous scientific methodology." The one who opened my eyes (pun intended) was Art Coury. Those who know Art know what I mean. He worked his way under my coating and introduced me to so many dedicated, venerable industrial scientists that I had no choice but to cast it off. I've since learned a lot about and from SFB member scientists and entrepreneurs of industry, to my benefit.

Notwithstanding such social education, the science of the Society was my passion. As was the case with many of my bioengineering students at UCLA, I found that the "bio" component of some bioengineers presenting at SFB Annual Meetings was deficient. Toward this end, I organized symposia, workshops and tutorials on subjects like immunology and biofilms that stressed biological concepts. Two people who made the Society's approach to science most meaningful to me I might call the "Duke of Confront" and "Duchess of Inclusion." The Duke was Jim Anderson. Jim was cut from the same cloth as Harold Frost, an icon of orthopaedics who did not suffer fools lightly. I knew Harold, who appreciated my love of science and befriended me because of it. My mentors at Caltech had trained me not to emulate Jim or Harold. But their criticisms — the scientific parts — were right on. The Duchess was Lynne Jones. She was scientifically sound and understood orthopaedics and biomaterials, but she made her points by asking non-confrontational, incisive questions that drew people into the conversation. Her administrative skills were legion, and she used them to guide me through my tenure as various officers in what became the Biomaterial–Tissue Interaction SIG.

I never got to know Buddy Ratner or Jonathan Black well, but I cannot think of SFB without them. Beyond his research achievements, I was drawn to Buddy's dedication. Through the few interactions we had, I realized his commitment to his graduate students and SFB, as evidenced in his *Biomaterials Science* textbooks weighing down my shelves. Sadly, I was not a good enough instructor to apply them in the classroom beyond serving as references. Jonathan was a fellow skeptic, and his pronouncements launched me on the way to my favorite biomaterials aphorism: "The greatest challenge to biocompatibility is time."

I shall leave it to others to decide what, if anything significant, I contributed to SFB. My presentations were certainly different because my model, bone chamber intravital microscopy, was unique. If need is a criterion for judging a work, perhaps our most significant contribution was our demonstration that 50:50 PLGA acidosis during in situ resorption in bone is physiologically not significant. In spite of the fact that our result has been confirmed by others, I am told that grant applications, including the acidosis canard, still appear. My participation in the fight against presentation of proprietary materials and methods was satisfying. My insistence that every abstract I reviewed have a hypothesis may have irked some, but I'm just a scientist and can countenance no other approach. When your life is motivated by uncertainty and failure, the prime afflictions of scientists, you respond negatively to superficiality. A hypothesis is a scientist's evidence that he or she understands the literature sufficiently to reason out a logical result of the experiment proposed. In any case, as this essay indicates, what is most professionally satisfying about SFB is the quality of the members who provide its substance. Most personally satisfying is the friendship of so many of them and helpfulness of the supporting staff, particularly Dan Lemyre, who has rescued me more times than my ego would allow me to admit.

# Letter to the Editor

*By Elaine Duncan*

The worn-out saying, "If the only tool you have is a hammer, you treat everything as if it were a nail," is also known as the Law of the Instrument. I can't think of a more fitting characterization for the misguided decision to charge $25 for abstract submissions for the 2018 Society For Biomaterials Annual Meeting. To add insult to injury to the poor nail, the fee was upped to $50 for "late" abstracts with $25 coming back at registration. Aside from the strange mathematics, we need to examine the motivation behind this decision and why a hammer was deployed.

The explanation was that there were too many "no shows" for the 2017 Minneapolis meeting at posters and podium presentations. This was "embarrassing."

What was the forensic breakdown of these "no shows"? How many were foreign submissions whereby the presenter might have been concerned over the travel ban rhetoric or could not get a visa? How many papers were duplicates of papers presented at the ORS or other earlier spring meetings? Were any of these "no shows" members?

During the Montreal Annual Meeting, I volunteered to help to "get the word out" to the hundreds of medical device manufacturers in our region, folks at the University of Minnesota (who were having a device meeting close to the same time as our own) and **Medical Alley** … none of which happened because the Society For Biomaterials decided to hire a "professional" PR company for promotion. Needless to say, the 2017 Annual Meeting attendance fell far short of its potential. We might have had a lot more **local** abstracts and, thus, **local** attendance had there been even a reasonable thought to **local** organization early enough to make an impact on abstracts. Oh, and I seem to recall bylaw changes that removed the need for a local organization. Hum.

Inflicting an abstract fee on students and professors doing biomaterials research is not going to solve the "embarrassment" problem. It may drive away otherwise important research and push it to meetings that have no fee. Many submitters do not have any funding for meetings **until** their abstract is accepted.

What I can't understand is why an "industry" person like me must point this out to a Society that has become extremely focused in the last decade on academic contributors. There are so many, many other ways to attack this problem without throwing up a barrier against the very scientists we need, with a disproportionate impact on the youngest!

Another saying I frequently apply is, "Don't just do something; sit there!" This mantra reminds me to not feel compelled to take action when I don't know enough to even know the direction to move. From where I sit, I doubt it was really necessary to rush this fee into practice for the 2018 Annual Meeting, when instead the Society office might have been scouting **new**, **local** potential attendees to drive up the abstracts out of the hundreds of medical device companies in the region, massive universities within a four-hour drive and other untapped resources.

**"ANOTHER SAYING I FREQUENTLY APPLY IS, 'DON'T JUST DO SOMETHING; SIT THERE!' THIS MANTRA REMINDS ME TO NOT FEEL COMPELLED TO TAKE ACTION WHEN I DON'T KNOW ENOUGH TO EVEN KNOW THE DIRECTION TO MOVE."**

Despite my reticence about "doing something," I do hasten to write this letter to the editor, hoping to appeal to our better angels and ask that we act like a **society**. In the future, can we consider the impact of our actions (or lack of action — such as advanced planning) before we impose a "fine" on the majority due to the acts of the minority? Maybe the way the old-fashioned Council meetings retarded sudden action was prudent after all. Maybe there was a reason to have a **local** planning committee. Hum.

# Members in the News

*By Helen H. Lu, Member-at-Large*

SFB members: I am honored to serve as your 2017 – 2018 member-at-large. I will be **your** representative on both the Board of Directors and SFB Council, and I will serve as your representative on other committees so that members have a clear voice for SFB direction. I plan to focus my efforts on three areas: effectively engaging and representing the membership, encouraging scientific excellence and program relevance, and enhancing community building. With your help, we can help SFB grow and maximize the value of your membership. I look forward to your ideas and feedback about SFB (just email me at hhlu@columbia.edu)!

Please see below for this quarter's exciting member news and accomplishments.

## MEMBER NEWS

**Amit Bandyopadhyay**, a Herman and Brita Lindholm Endowed Chair Professor at the School of Mechanical and Materials Engineering at Washington State University, was one among the 12 new inductees to the Washington State Academy of Sciences (WSAS) in recognition of his significant contribution to the advanced manufacturing of structural and biomaterials elements and education of the next generation of material scientists. Read more at news.wsu.edu/2017/07/27/researchers-named-washington-state-academy-sciences-2.

**Bikramjit Basu** of the Indian Institute of Science, Bangalore, has been elected a Fellow of the Indian National Academy of Medical Sciences, being one of the few engineers so far to be elected in 50 years of the history of the academy.

**Susmita Bose**, a Herman and Brita Lindholm Endowed Chair Professor at the School of Mechanical and Materials Engineering at Washington State University, was one among the 12 new inductees to WSAS in recognition of her significant contribution to the development of advanced biomaterials and education of the next generation of material scientists. Read more at news.wsu.edu/2017/07/27/researchers-named-washington-state-academy-sciences-2.

**Christopher N. Bowman**, PhD, James and Catherine Patten Endowed Chair, distinguished professor of chemical and biological engineering, and clinical professor of restorative dentistry at the School of Dental Medicine, University of Colorado at Boulder, was elected a Fellow of the National Academy of Medicine. Read more at adea.org/BDEBlog.aspx?id=37985&blogid=27619.

University of Memphis biomedical engineering faculty **Dr. Joel D. Bumgardner** and **Dr. Amber Jennings** served as editors and contributors to a recently published two-volume series on chitosan biomaterials: *Chitosan-Based Biomaterials – Volume 1: Fundamentals* and *Chitosan-Based Biomaterials Volume 2: Applications*. Both volumes are published by Woodhead Publishing, October 2016. The books bring together topics on the basic properties, chemistry, processing/modifications and characteristics of the chitosan polymer and topics on biomedical engineering applications in tissue/regenerative medicine, nanoparticle and drug delivery. In addition, the text provides many systematic protocols to help researchers with basic methods for manufacturing, using, characterizing and evaluating chitosan materials for desired applications.

**Eun Ji Chung**, a Gabilan Assistant Professor at the University of Southern California (USC), affiliated principal investigator (PI) at the USC Stem Cell Department and member of the USC Norris Cancer Comprehensive Center, has been featured as one of the 2017 AIChE 35 Under 35 (read more at aiche.org/chenected/2017/07/aiche-35-under-35-bioengineering). She has also been named a 2017 Emerging Investigator for *Biomaterials Science* (read more at pubs.rsc.org/en/content/articlehtml/2017/bm/c7bm90033c). Dr. Chung's research group focuses on developing nano-biomaterials for theranostic applications in atherosclerosis and kidney diseases.

**Ahmed El-Ghannam**, associate professor of tissue engineering and biomaterials at the University at North Carolina at Charlotte, will be organizing and chairing the 34th Southern Biomedical Engineering Conference, held from Mar. 8 – 10, 2018, in Charlotte, North Carolina. Read more at msacad.org/34th-sbec-2018.

**Andrés García**, the Rae S. and Frank H. Neely Endowed Chair and Regents' Professor in the Woodruff School of Mechanical Engineering and the Petit Institute for Bioengineering and Bioscience at the Georgia Institute of Technology, wrote that the Georgia Clinical & Translational Science Alliance (CTSA), comprising Emory University, Georgia Tech, the University of Georgia and Morehouse School of Medicine, has been awarded a five-year, $51 million Clinical and Translational Science Award (CTSA) from the National Institutes of Health. The Emory University-led Georgia CTSA will focus on transforming the quality and value of clinical research and translating research results into better outcomes for patients. Dr. García serves as the Georgia Tech PI for the Georgia CTSA.

**Michael Gower**, assistant professor of chemical engineering at the University of South Carolina, and his lab's research was highlighted during a press conference at the Fall 2017 ACS National Meeting. His team is investigating the effect of biomaterial implant on fat tissue. They report that implant of

tissue engineering scaffolds into fat protects mice from high-fat-diet-induced obesity and glucose intolerance. The group is now focusing on translating these findings into treatments for type 2 diabetes. Read more at eurekalert.org/pub_releases/2017-08/acs-gft072417.php.

**Jeff Karp**, an associate professor of medicine at Harvard Medical School and the Brigham and Women's Hospital and co-founder of Gecko Biomedical, is celebrating a major milestone following European regulatory approval for Gecko's SETALUM Sealant, paving the way for groundbreaking surgical solutions. Read more at geckobiomedical.com/gecko-biomedical-receives-ce-mark-approval-for-setalum-sealant.

**Surya Mallapragada**, Anson Marston Distinguished Professor, Carol Vohs Johnson Chair and associate vice president for research at Iowa State University, has been elected a Fellow of the International Academy of Medical and Biological Engineering (IAMBE). IAMBE is made up of Fellows who are recognized for their outstanding contributions to the profession of medical and biological engineering. Read more at news.engineering.iastate.edu/2017/09/21/cbes-mallapragada-to-international-academy-of-medical-and-biomedical-engineering.

**Devesh Misra** of the Department of Metallurgical, Materials and Biomedical Engineering at the University of Texas at El Paso, has been selected to receive the Lee Hsun Award of the Shenyang National Laboratory for Materials Science, Institute of Metals Research, Chinese Academy of Science, Shenyang, China. This award is presented to internationally recognized leaders in materials science and engineering. At the award ceremony, Prof. Misra will deliver a lecture titled "The Intersection of Materials Science and Biology: The Biomaterials Science."

**Syam P. Nukavarapu** has been promoted to associate professor of orthopaedic surgery biomedical engineering at the University of Connecticut Health. His innovative research program includes basic science, engineering and translational elements of biomaterials science and engineering, with current projects in bone and cartilage regeneration as well as bone–cartilage interface tissue engineering.

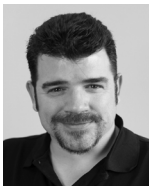
**Krishnendu Roy**, the Robert A. Milton Chair at Georgia Institute of Technology, writes that Georgia Tech has been awarded a five-year, $20 million grant to establish an Engineering Research Center (ERC) for Cell Manufacturing Technologies (CMaT). Prof. Roy will serve as ERC director, and the vision of CMaT is to transform the production of therapeutic cells into a large-scale, low-cost, reproducible, high-quality engineered manufacturing process for broad industry and clinical use. In addition to Georgia Tech, the University of Georgia, University of Wisconsin – Madison and University of Puerto Rico – Mayaguez are major partners, alongside several affiliate institutions. SFB members involved include **Johnna Temenoff**, **Andrés García** and **Ravi Kane** (Georgia Tech); **Bill Murphy**, **Kris Saha** and **Randy Ashton** (the University of Wisconsin – Madison); **Madeline Torres-Lugo** and **Jorge Almovar** (the University of Puerto Rico – Mayaguez); **Lohitash Karumbaiah** (the University of Georgia); and **Todd McDevitt** (Gladstone Institutes). CMaT's research goals are to develop omics-based tools for stem cell and T cell characterization that couple modeling with efficacy and safety data to identify surrogate critical quality attributes (CQAs); cell-process analytics and sensors to measure cell quality, both at the initial starting point and throughout the manufacturing processes; scale-up and scale-out technologies; new purification and separation technologies; high-throughput methods for rapid potency and safety assays; and industrial design principles, automated closed system manufacturing and process-flow modeling concepts. Moreover, CMaT will engage deeply and broadly in education, inclusivity and workforce development through a comprehensive program involving underrepresented students and teachers from high schools, students with disabilities, veterans, technical and community college students and undergraduate and graduate students. Read more at nsf.gov/awardsearch/showAward?AWD_ID=1648035&HistoricalAwards.

**Tatiana Segura**, professor of chemical and biomolecular engineering at UCLA, and a team of researchers including **Thomas Barker** (University of Virginia) published a study in *Nature Materials* titled "Hydrogels with Precisely Controlled Integrin Activation Dictate Vascular Patterning and Permeability." This study demonstrates that specific integrin binding from hydrogels can be harnessed to guide vascular morphogenesis in vitro and in vivo. Read more at rdcu.be/wBhA.

**Guigen Zhang** recently became the F. Joseph Halcomb, III, MD Endowed Chair and Professor and Chair of the F. Joseph Halcomb, III, MD Department of Biomedical Engineering at the University of Kentucky. Read more at engr.uky.edu/2017/08/22/zhang-new-chair-bme. Dr. Zhang is also the executive editor of the *Biomaterials Forum* and the current president of the Institute of Biological Engineering.

# Staff Update

*By Dan Lemyre, CAE, IOM, Executive Director*



Hello from the Society For Biomaterials headquarters! The Society's Board of Directors and governing Council met on Nov. 3, 2017, at SFB headquarters in Mount Laurel, New Jersey. They reviewed the 2018 budget and continued their work implementing the strategic plan for the Society. Following is a brief summary of the actions and plans for the Board, Council, committees and task forces.

## BOARD/COUNCIL

Chair David Kohn, PhD

The Board is investigating the possibility of a 2020 fall symposium in Hawaii with the Japanese Society for Biomaterials. They are in the process of selecting a venue for the 2021 meeting; Chicago, Cleveland and Baltimore are being considered. (Nashville and New Orleans had already been contacted, but do not have space available.)

The Board is implementing the strategic plan through the committee structure with the addition of two new task forces, one dedicated to increasing the Society's social media presence and the other considering the development of a new Fellows designation for SFB members. This distinction would be different from the IUSBSE Fellows program.

## AWARDS, CEREMONIES AND NOMINATIONS COMMITTEE

Chair Nicholas P. Ziats, PhD

The committee has received 48 award nominations but did not receive any nominations for the two officer positions. The committee recruited a slate of officers to stand for election in 2018. There were 13 Clemson Award nominations, nine Student Award for Outstanding Research nominations and eight Young Investigator Award nominations. As of this writing, the Council has ratified the slate of officers and award recipients. Award announcements and officer candidates will be featured in the next issue of the *Biomaterials Forum*. Thank you to all who nominated, and please start thinking about possible nominations for next year — especially those who may have interest in serving on the Society's Board of Directors!

The committee is also soliciting applications for the 2018 C. William Hall Scholarship and the Cato T. Laurencin Travel Fellowship. The nomination deadline for both awards is Dec. 1, 2017.

## BYLAWS COMMITTEE

Chair Benjamin G. Keselowsky, PhD

The committee will continue to monitor the Society's operations and strategic direction to determine if amendments may be necessary. They are currently working to expand and define the role of the President's Advisory Committee.

## EDUCATION & PROFESSIONAL DEVELOPMENT COMMITTEE

Chair Jan Stegemann, PhD

The committee received 10 grant applications for the 2018 Biomaterials Day program. Per direction from Council, this program is being redesigned to provide support and direction to as many institutions as possible, while curtailing the fiscal impact on the Society.

The Committee is working on a "Career Catalysis" track for the Annual Meeting to provide members at all career levels with professional development opportunities.
The Committee is also working on mentorship opportunities for new and seasoned members. If you are interested in being a mentor or finding a mentor, please email info@biomaterials.org.

## INDUSTRIAL AFFAIRS COMMITTEE

Chair Peter Edelman, PhD

The committee is promoting activities of interest to members from industry and working to support the "Career Catalysis" initiative of the Education & Professional Development Committee. This includes actively supporting the Fourth SFB Business Plan Competition which was developed by the Biomaterials and Medical Products Commercialization SIG, and working to continue the Biomaterials Technology in Industry track at the 2018 Annual Meeting in Atlanta, Georgia.

## FINANCE COMMITTEE

Chair Elizabeth Cosgriff-Hernandez, PhD

With poor hotel pickup in 2017, the Society realized an attrition penalty from the Minneapolis Hilton. Coupled with lower than expected registration and exhibit sales, the 2017 financial outlook is dramatically below budget. The committee was charged to develop a 2018 budget that would return the Society to a financially sustainable operations model, returning a positive net income. This will include efforts to reduce expenses, grow sponsorship revenue and implement modest increases in membership dues, SIG dues and Annual Meeting registration fees.

Most importantly, the committee, Board and Council urge all members to book their stay for the Annual Meeting at the conference hotel! The Society requires a large amount of space to conduct our meeting, and to accommodate the demands for that space, the hotel must be guaranteed a certain number of room nights. Repeated failure to deliver on the contracted number of hotel bookings jeopardizes the Society's ability to find viable space in the future.

## LIAISON COMMITTEE

Chair L.D. Timmie Topoleski, PhD

The committee is supporting a first-time symposium at the MatSciTech 2018 meeting currently organized by TMS, AIST, ACerS and ASM. This will be SFB's first interaction with the MatSciTech meeting, and future collaborations will be determined by the success of this initial event. The committee will also be reaching out to UBM Canon meeting attendees (hosts of MD&M meetings). In addition, SFB will be supporting a Summer School program at the University of Bordeaux in conjunction with the European Society For Biomaterials.

## MEMBERSHIP COMMITTEE

Chair Christopher Gehrmann, PhD

The committee is working to develop strategies to increase membership, especially in industry and clinical sectors. These include a social media campaign highlighting some of the "Faces of SFB" and an email campaign designed to win back past members and convert non-member Annual Meeting attendees, webinar participants and website visitors to membership.

## PRESIDENT'S ADVISORY COMMITTEE

Chair Liisa Kuhn, PhD

The committee is finalizing an SFB code of ethics and will publish it shortly. The committee is also working to put together a panel on ethics for the 2018 Annual Meeting.

## PROGRAM COMMITTEE

Co-Chairs Robert Hastings and Johnna Temenoff, PhD

More than 900 abstracts were submitted to the 2018 Annual Meeting, an increase of more than 5 percent over 2017. The Society will host the 2018 Annual Meeting in Atlanta, Georgia, with a theme of "Exploring the Nexus of Research and Application." Since its founding, Atlanta has been a hub of commerce and transportation, known for bringing together diverse people and ideas. Similarly, the Society has a long history of being the hub for multidisciplinary materials research and applied solutions for healthcare. Atlanta thus provides the perfect backdrop for the 2018 Society For Biomaterials Annual Meeting, which will act as a nexus to further opportunities for collaboration across diverse scientific disciplines, from biology and material science to chemistry, physics, medicine and engineering.

The committee will meet to finalize the 2018 program in December 2017. Please visit the meeting website at 2018.biomaterials.org for the most up-to-date information on the 2018 Annual Meeting.

## PUBLICATIONS COMMITTEE

Chair Sachin S. Mamidwar, MBBS, MS

The committee continues its work with the biweekly e-newsletter, *Biomaterials Bulletin*, and the *Journal of Biomedical Materials Research* while also working to expand services available on the SFB website.

## NATIONAL STUDENT CHAPTERS

President Daniel Hachim

Officers are working with the Education & Professional Development Committee to develop content for the Career Catalysis track and to coordinate student activity within SIGs.

## SIG REPRESENTATIVE

Sarah Stabenfeldt, PhD

Proposed SIG budgets have been submitted and reviewed by the Board. 2018 budget approvals will be communicated shortly, and SIGs will be planning many activities — from social events to poster awards — in conjunction with the 2018 Annual Meeting in Atlanta, Georgia.

***If you have any questions,***

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

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# Government News

*By Carl Simon, Government News Editor*

The U.S. Food and Drug Administration approved the first genetically modified cell therapy for the treatment of leukemia on Aug. 30, 2017.[1,2] The treatment (tisagenlecleucel) is an "autologous genetically modified immunocellular therapy indicated for the treatment of pediatric and young adult patients three to 25 years of age with relapsed/refractory (r/r) B-cell acute lymphoblastic leukemia (ALL)."[3] B cell acute lymphoblastic leukemia is the most common malignancy diagnosed in children in the United States. The treatment is a chimeric antigen receptor (CAR) T cell therapy, where the patient's T cells are genetically modified to express a CAR that targets antigen CD19 expressed by B cells. For the treatment, cells are harvested from the patient via leukapheresis and shipped to a manufacturing facility, where they are engineered to express the CAR against CD19. The manufacturing process takes 22 days, and then the modified cells are shipped back to the hospital, where they are administered to the patient. The potency test for release of manufactured batches is the measurement of interferon-γ production upon stimulation by CD19+ cells. The interim endpoint in the pivotal study showed remission in 52 of 63 patients ($P < 0.001$ at 95 percent, confidence interval 71 percent to 91 percent).[3] The cost of the treatment is reported to be $475,000.[2]

*Disclaimer: Certain equipment and instruments or materials are identified to adequately specify experimental details. Such identification does not imply recommendation by the National Institute of Standards and Technology (NIST), nor does it imply that the materials are necessarily the best available for the purpose. This article, a contribution of NIST, is not subject to U.S. copyright.*

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# Student Chapter Update

*By Daniel Hachim and Angela Cleri*

We have had very interesting and successful Biomaterials Days hosted by our student chapters. The 6th Annual Biomaterials Day at the University of Florida was held on Mar. 31, 2017, with the theme "Exploring the Capabilities of Biomaterials." This year's symposium drew the University of Florida SFB chapter's largest crowd yet, with approximately 250 registered attendees. The event consisted of presentations from distinguished researchers in the field, including a keynote address given by Dr. Darrell Irvine from MIT titled "Engineering Immunity Against Cancer and Infectious Disease." In addition, the chapter hosted several outstanding plenary talks from Dr. Evan Scott (Northwestern University), Dr. Michele Manuel (the University of Florida) and Dr. Douglas Weber (Defense Advanced Research Projects Agency).

To open the floor for conversation about research, student attendees were also given the opportunity to compete in a poster session. Six PhD students from mechanical and aerospace engineering, biomedical engineering and chemical engineering competed in an oral presentation competition. Representatives from regional companies participated in an industry session to network with students about potential careers in the field of biomaterials after graduation.

The Biomaterials Day at North Carolina State University, held Sept. 22, 2017, was also a huge success. This year, the event focused in multiple areas, including biomaterials for medical applications and tissue engineering and regenerative medicine, as well as industry-oriented topics such as developing new technologies and commercialization and regulatory challenges for biomaterials and medical products. The event also featured four keynote presentations: Dr. Frederick Schoen (Department of Pathology, Harvard Medical School) with "Evolution of Cardiac Valve Prostheses: Collaborative Innovation in Design, Biomaterials and Cell-Matrix Biology," Dr. Karen

[CONTINUED ON PAGE 12]

# Updates from the Biomaterials and Medical Products Commercialization SIG

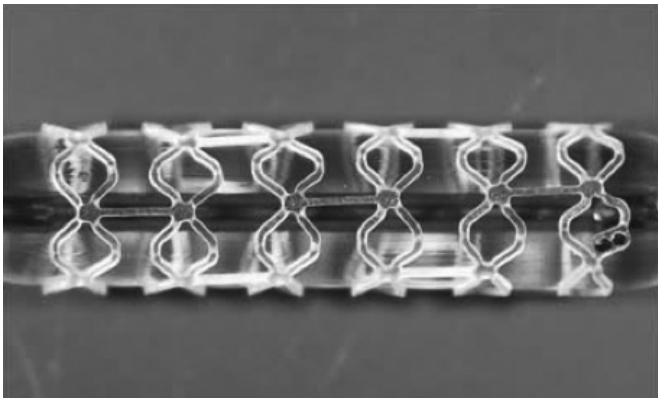
*By Puneeth Shridhar and Prashant Kumta*

Puneeth Shridhar

Prashant Kumta

We find ourselves in the midst of a revolution in biomaterials. Promising drugs and devices move toward commercialization, and 2018 could bring both breakthroughs and downfalls in commercialization. From CE mark approval of the first biodegradable metallic stent — Magmaris (Dreams2G) from BIOTRONIK — to efforts to bring additive manufacturing (AM) to hospitals for customized biomaterial based-solutions, the future seems to be promising for formulas seeking both U.S. Food and Drug Administration approval and to transform human lives.[1]

**Figure 1**



A Biodegradable Stent

Medical AM has been defined as "the manufacture of dimensionally accurate physical models of human anatomy derived from medical image data using a variety of additive manufacturing technologies." However, this definition continues to transform. Various biomaterial sectors that have adopted AM, including drugs, medical devices, lab on chips, biosensors, reconstructive surgeries (implants and prosthetics), cell printing and medical education, are thriving and prospering.

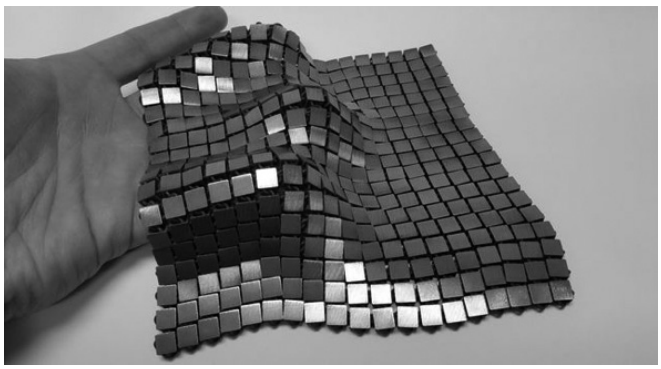
Recently, disruptive biomaterial technologies have enabled engineers and clinicians to collaborate in solving complex problems that require advanced manufacturing capabilities to develop medical applications. With the introduction of AM technologies, advanced medical tools can be developed for a better quality of medical diagnosis and treatment with cost-effective solutions.

Often, medical diagnostics takes a long time and requires biological samples to be transported from place to place. The new generation of diagnostic kits are able to provide an all-in-one lab on chip capability thanks to AM technologies.

The rapidly evolving drug benefit categories can be broadly classified into three groups: increased product complexity, personalization and on-demand manufacturing. A number of biomedical cell printers use the AM approach, with large-diameter nozzles to minimize shear loading on cells as they are deposited to enhance cell viability. Simulation has become an increasingly important tool in both medical and surgical education. 3D-printed anatomical models are helping shape the future of medical training.

After more research and development, AM has become capable of producing complexly shaped materials that can be used in applicable parts. In reconstructive surgery, options range from scaled models of the skeleton for preoperative planning (based on actual anatomy or estimated ideal anatomy predicated on the mirror image of the unaffected side), prosthetics, custom inert implants and biocompatible scaffolds. One intriguing application of AM is the process of 3D printing of implants and plates (especially made from titanium) through the process of electron beam melting. This fabrication method has been used to overcome inadequacies of other synthetic materials in terms of biocompatibility and strength.

**Figure 2**



"Space Fabric" Created Using AM at Jet Propulsion Laboratory/NASA

## Updates from the Biomaterials and Medical Products Commercialization SIG [continued from page 11]

Polymers and metals are currently considered as commercially available materials for AM processes. For instance, functionally graded materials (FGM) is noted to be an effective application of AM because AM offers the ability to control the composition and optimize the properties of the built part. A simple example of FGM using AM technology is the missile nose cone, which includes an ultra-high-temperature ceramic graded to a refractory metal from outside to inside; it is used for sustaining extreme external temperatures.

AM for biomaterials is poised to greatly benefit the majority of people living in developing countries, helping them to receive appropriate and accessible medical care and improve their quality of life. In the industrialized world, it has enormous potential to bring down the spiraling cost of healthcare.

Presently, using a range of materials and creating complex 3D features with high aspect ratios continues to be a challenge. The cost and economy of scale is another issue that needs to be tackled to make units personalized and replicable. Sustainable design and manufacture of medical products with minimum material and energy usage for achieving zero waste and carbon footprint also remains to be addressed.

Furthermore, the future is bright for manufacturing sophisticated AM-based micro machines composed of moving components. These capabilities could find applications in drug delivery, applications that require control of microenvironments around delivered cells or engineered tissues, or implantable medical devices (such as stents). They also could bring the field a step closer to developing soft, miniaturized robots that can safely interact with humans and other living systems.

New centers for biomaterial innovation continue to come online, and existing centers continue to flourish in the United States, Europe and across the world. Their common agenda is to develop next-generation devices using game-changing biomaterials in partnership with industry. In 2017, we have also seen a spike in biomaterial startups that have embarked on an ambitious journey to leave their footprint in an aggressive biomaterial business community. Peytant Solutions (human amnion coverings), Renerva (hydrogel for nerve repair), Evocative (mycelium solutions), Ortho Regenerative Technologies Inc. ("sticky" biopolymers with PRP), Silicon Therapeutics ("living" therapeutics), Dimension Inx (3D printing of bioactive "tissue papers"), Hyalex Orthopaedics (cartilage-mimicking polymer), CELLINK (laboratory bioprinters), StemPharm (hydrogel scaffold) and AsclepiX Therapeutics (controlled drug delivery) are just a few.

While carmakers like Ford are using biomaterial technology to replace petroleum-based products used to make plastic, large biomedical companies like Medtronic continue to re-strategize their evolving positions in the biomaterial space. Furthermore, Abbott recently pulled the plug on a once-promising bioresorbable Absorb stent. This was followed by Boston Scientific scrapping its Renuvia biodegradable program. Yet, such failures only solidify and strengthen our determination to succeed.

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## Student Chapter Update [continued from page 10]

Burgh (Department of Small Animal Medicine and Surgery, the University of Georgia) with "Everything Is an Opportunity: What I Learned While Building 3D Tissue Test Systems," Jeffrey Koslosky (Cortland Medical Business) with "Biomedical Textile Product Development: An Industry Perspective" and Rick Lawless (Biomanufacturing Training and Education Center, North Carolina State University) with "Distribution of Human Tissues and Medical Devices: Requirements, Challenges and Careers."

These talks were followed by a successful poster session, instrument demonstrations and a closing award session. Ismael Muhamed was awarded first place for his poster titled "Engineering Fibrin Nanoparticles to Enhance the Early Stages of Wound Healing," followed by Ashish Kapoor and his poster titled "Novel Fiber-Based Sensors for Prosthetic Environment Monitoring." For more information and pictures, please visit sfbiomaterials.wordpress.ncsu.edu.

# Updates from the Biomaterial-Tissue Interaction SIG

*By Antonio Merolli*

Several months have passed since our Annual Meeting in Minneapolis. For those who attended the SIG-BTI session, two memories are probably still very fresh: the quality of the presentations and the many people standing because they could not find a seat (and the room was big!). Of course, these occurrences are interconnected. The large number of quality submissions led to many papers and a crowded poster section — another very nice occurrence.

Any bad news from this event? Well, maybe one. For those of us who use the acronym "BTI" for our SIG, we had to face the "other" BTI at the Annual Meeting: Biomaterials Technology in Industry. This should remind us, maybe, to use our name in full because it has a meaning: "Biomaterial–Tissue Interaction" addresses the core of biomaterials science and pulls together the most interdisciplinary knowledge of the field. Let's declare our broad vision, which is intrinsic in our name, so new candidate members will realize that this is the SIG they have to join.

The study of biomaterial–tissue interaction has many peculiarities, with many technical difficulties associated with the study of the interface between biomaterials and tissues. We face longer durations for analysis compared with most materials science testing procedures. Living tissue may require complex and lengthy experiments in vivo, with many limitations in collecting the desired number of samples for statistical significance. We should not forget, at this point, how the study of the biomaterial–tissue interaction in humans may amplify these difficulties. There is seldom the opportunity for implant retrieval. We may only rarely have a significant number of specimens (sometimes we may have only one). However, isn't the biomaterial–tissue interaction in humans what all the upstream in vitro and in vivo studies want to define?

The scarce literature in biomaterial–tissue interaction in humans may be associated in part with these difficulties. It is possible, however, that the standard flow in the editorial and reviewing process of most scientific journals is not adequate to receive these kinds of studies.

Has anyone experienced criticism (and maybe rejection) because of the low number of samples? Has anyone received a request to "repeat" the histology? We have discussed these problems with a major publisher group, Springer Nature, and we have been able to reserve the space for a special issue in the Journal of Materials Science: Materials in Medicine (JMSM). The title of the special issue is "Biomaterial–Tissue Interaction in Humans," and the editors are Antonio Merolli (Rutgers – The State University of New Jersey), Floyd Karp (the University of Washington) and Nicholas Ziats (Case Western Reserve University). Potential authors are invited to contact the editors or submit their papers under the specific heading on the JMSM website.

We have a final initiative to promote our SIG's scientific impact. In our 2018 budget, we will devote a sum for an Outstanding Paper Award. This will be launched at the next SFB Annual Meeting in Atlanta with other initiatives that will give us visibility and increase our networking capability.

So, it is good time to get involved in the study of biomaterial–tissue interaction, and this is motivation to expand the field even more!


## *Call For Cover Art*

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

**DEADLINE:** Accepted on a rolling basis.
**INSTRUCTIONS:** Please email artwork (digital images, artistic creations, etc.) to SFB headquarters and the Executive Editor of the Biomaterials Forum, Guigen Zhang, info@biomaterials.org, guigen.bme@uky.edu. All artworks with biomaterials relevance that have not appeared as a Forum cover are welcome. Multiple submission is permissible.
**SELECTION PROCESS:** All submissions will be reviewed by the Biomaterials Forum Executive Editor. Selected artworks will appear as the cover of a future issue of *Biomaterials Forum* along with a brief "On the Cover" description of the subject and name/affiliation of the creator.
**FORMAT:** High-resolution electronic version in .gif, .tiff, or .jpeg file format.

# Biomaterials Education

## STRATEGIES TO ENCOURAGE CRITICAL THINKING AND EFFECTIVE WRITING

*By C. LaShan Simpson, Jenna Mosier, Nancy Nguyen and Kadie Parker*

Excelling at soft skills remains an Achilles heel for engineers, with written communication continuing to be the weakest of them all. Most engineering students only experience writing during their curricula in English composition courses, technical writing courses and end-of-semester term papers, which rarely receive feedback. While it is true that engineering skills rely heavily on math and science, effective communication is essential to engineers for relaying what exactly they are studying, researching or doing in a way that convinces the audience that they have uncovered a problem worth solving — and that they will be the ones to solve it. Soft skills and communication are necessary for advancement in the workplace — sometimes even more important than technical knowledge.[1] Focusing on these soft skills better prepares engineers for the workforce by balancing scientific, practical knowledge with the mature and rigorous skills needed for effective writing. Critical writing can be incorporated into courses and curricula through informal writing assignments, scaffolding, flexible writing and peer reviews.

Technical knowledge amongst engineering graduates is at all-time high; however, those same graduates lack interpersonal and social skills that would be required in present-day job settings.[2] Some of the skills that these graduates lack are effective communication and teamwork, both highly important in a job setting for engineers who have to work closely and collaboratively with coworkers.[2] While technical expertise and knowledge have profound impacts on the skills employers look for when hiring graduates, employers have started emphasizing the importance of soft skills such as integrity, communication and flexibility. The emergence of these soft skills is a result of the economic shift from an industrial to information society.[1] This means that there is a need to further emphasize soft skills early in higher education curricula so that students can grasp the importance of soft skills in the beginning of their academic career, long before starting their professional careers.[1]

Here, we aim to offer strategies that could be used to improve written communication skills for engineers and encourage critical thinking. These techniques can be incorporated into any course. The strategies are only a few examples discussed in the book *Engaging Ideas* by John C. Bean.[3]

### EXPLORATORY WRITING

Exploratory writing, also known as informal writing, journaling or brainstorm writing, has been the most valuable teaching strategy to promote critical thinking. This type of writing is typically loosely structured and tentative, which helps writers form and organize their ideas without worrying about consequences. These assignments are usually "thinking pieces" that are designed to help students discover, develop and clarify their own ideas.

Despite the beneficial effects of exploratory writing, there are objections concerning this teaching technique. Professors believe that it is time consuming to read all of the students' papers. However, Bean argues that teachers should read with the intention of stimulating creativity and focusing thoughts.[3] Many students need this supervision to remain motivated. The trick to this teaching strategy is to read some of each student's paper, not all of it. This approach helps instructors coach their students' thinking processes.

Another complaint concerning exploratory writing is that students regard it as busywork. Some students dislike the open-ended, goalless nature of writing, and others believe that it is a complete waste of time if no grading is involved. However, the most prominent reason for this form of thinking could be that students have not yet received a question or problem that they are truly interested in. In short, these students believe that there is not a need for exploratory writing because they have no motivation to explore. The best response to these objections is to help students see the value of exploratory writing. One approach is to incorporate exploratory writing directly into the texture of the course (for example, class discussion). Many instructors would either open class with a question or put students in small groups to discuss and share ideas for formal essays or exams. Another method to help students see the value of exploratory writing is constantly letting students know that it is something expert writers do. Often, students will have more interest if they see their teachers or any skilled professionals use exploratory writing as a way to organize their ideas.

Some will also argue that exploratory writing promotes bad writing habits since it is generally done without the concern of sentence structure, organization, spelling or grammar. This encourages writers to be sloppy. However, exploratory writing is meant to be messy because thoughts are messy. Worrying about grammar, spelling or organization when you are trying to discover and clarify ideas can discourage any writer's creativity. But, students should not confuse exploratory writing with the writing they must produce in exams, where structure and formal writing are important.

These explorative writing assignments are challenges that guide students to think critically on their own. It is a teaching technique that mainly focuses on the process, rather than the product, of thinking. It encourages students to be engaged with the course materials while enhancing learning and critical thinking. In addition to being active in classroom discussions, it also prepares students for class and forms a better final product essay.

## WRITING TO LEARN

Traditional writing has become associated with grammatical correctness and style, isolated from critical thinking. According to Bean, when writing is looked at in this view, it becomes just a learned skill through repeated grammar drills.[3] These repeated grammar drills are done by students being forced to write pointless essays that they are uninterested in, resulting in writing that teachers do not want to read. A message often portrayed by schools is that writing is a dull activity that only results in errors for teachers to find. The cost of this type of thinking is that writing gets disconnected from the writer's actual thoughts, resulting in a curriculum lacking critical thinking. Therefore, it is important for teachers to understand that writing should be taught as a process of critical thinking.

The Writing in the Disciplines movement is "learning to write" within a discipline-specific genre that goes with the student's major. This movement is to demand and empower students to use critical thinking. Along with these writing movements, there has also been an analogous movement focused on teaching critical thinking. Some students entering college simply see knowledge as the collection of correct information. To these students, writing means just demonstrating one's knowledge or facts, not opinions or particular views. These students are unaware that writing demands a high level of intellectual maturity and rigorous thinking. Bean suggests that one possible reason why students remain detached from their writing is because they are scared of having to defend an idea and are just in search of the "right answer."[3] Therefore, students should be taught to see the intellectual and emotional struggle that academic writing often involves.

Students typically indulge in writing one of three certain styles. Bean describes those styles as "and then," "all about" and "data dumping."[3] In the "and then" style, students write in chronological order without any meaning or structure. In the "all about" style, writers try to tell everything about their subject. This results in writing that does not clearly support the thesis. Lastly, there is "data dumping," which is usually a direct result of a student being overwhelmed by information and not knowing what to do with it. All three styles tend to result in poor writing that does not effectively defend an idea and thesis. These writing styles are the result of concrete reasoners who just focus on data, objects or things and not propositions. However, these styles are also thought to be caused by students who receive inadequately designed writing assignments and maladroit teaching.

## "SCAFFOLDING" WRITING

Typically, in the classroom setting, a course is oriented around one major writing assignment — either a research paper or something similar. The topic can be open ended; students choose and therefore have the freedom to find a topic that they find interesting. However, topics can also be assigned, giving students more time to focus on developing ideas and content rather than generating a subject, prompt, thesis and argument.

Both options, however, require the student to perform some sort of preliminary research to aid in developing a succinct and sound argument for the reader to follow. Often, this research can be aided by what Bean describes as "scaffolding" writing assignments.[3] The term refers to the creation of some sort of foundation or baseline to begin building on. Similar to scaffolding on a building, these sorts of writing assignments create a baseline for students to form their arguments around.

By narrowing research, scaffolding assignments help students to design and thoroughly extrapolate on a more effective, meaningful thesis with both the content and the intended audience in mind. Bean calls this a "skill-building" assignment that requires what may seem like more research than rhetoric to begin with to form a solid foundation of skills and ideas.[3] By incorporating more of these small assignments into the course, instructors and professors can more accurately gauge the student's progress and the student can interact with the topic. The mini assignments (explorations into specific areas or related topics) greatly encourage the revision process; in fact, some professors have used higher grades as a reward for revising and editing papers as the course continues.

Scaffolding engages students with the topic early enough so that they can formulate a more cohesive thesis. Often with undergraduates, and many writers in general, the most difficult and debilitating part of a writing assignment can be taking a persuasive stance and building a paper with the power to

change the reader's mind. As Bean explains, writing becomes more effective and successful when the author considers three important concepts: genre, audience and purpose.[3] Instilling this notion early allows students to focus on exactly what they hope to see their papers do.

Honing this scaffolding skill in engineering classes would provide an effective mechanism to train students to become better writers — and better communicators in general. Scaffolding stimulates more contact between student and instructor, allowing feedback and revisions to strengthen skills.

Being able to effectively communicate is paramount in the engineering field. However, most engineers lack the ability to write effectively and think critically and have shown a lack in soft skills. These weaknesses are a direct result of limited writing experiences confined to the basic English composition and technical writing courses within their curricula. To improve upon these shortcomings, it is important to introduce courses early within higher education curricula that emphasize critical thinking and soft skills, especially communication. Also, the workplace has shifted from being solely focused on technical knowledge to more toward soft skills and communication abilities; therefore, it is important that engineers begin refining these critical thinking and communication skills early in their academic careers so that they will be prepared when entering the workforce. Improving critical thinking, communication and effective writing can be achieved by incorporating informal writing assignments, scaffolding, flexible writing and peer reviews into courses and curricula.

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# Industry News

*By Steve Lin, Industry News Editor*

**Project Literacy**, which has been raising awareness for its cause at SXSW 2017, recently released a report ("2027: Human vs. Machine Literacy") that projects that machines powered by artificial intelligence (AI) and voice recognition will surpass the literacy levels of 1 in 7 American adults in the next 10 years. "While these systems currently have a much shallower understanding of language than people do, they can already perform tasks similar to [a] simple text search task … exceeding the abilities of millions of people who are nonliterate," Kate James, Project Literacy spokesperson and chief corporate affairs and global marketing officer at Pearson, wrote in the report. In light of this, the organization is calling for "society to commit to upgrading its people at the same rate as upgrading its technology, so that by 2030 no child is born at risk of poor literacy." Citing research from Venture Scanner, Project Literacy found that in 2015, investment in AI technologies (including natural language processing, speech recognition and image recognition) reached $47.2 billion. Meanwhile, data on U.S. government spending shows that the 2017 U.S. federal education budget for schools (pre-primary through secondary school) is $40.4 billion.

**Mazor Robotics Ltd.**, a leader in the field of surgical guidance systems from Israel, announced the closing of the third tranche equity investment by **Medtronic** pursuant to the executed agreement between the parties, as previously disclosed on Aug. 30, 2017. Mazor issued 1.04 million American Depositary Shares (ADSs) at $38.46 per ADS, which is equal to the weighted average price of the ADSs for the trailing 20-day period ending on and including Aug. 29, 2017, for an aggregate purchase price of $40 million. In addition, Mazor issued to Medtronic warrants to purchase an additional 1.21 million ADSs at an exercise price of $44.23 per ADS, which represents a 15 percent premium over the per share price for the $40 million equity investment. Medtronic has the right to exercise the warrants immediately in whole or in part, for cash, and they expire after 18 months from the issuance date. Medtronic's total investment in Mazor to date totals $72 million.

**Centinel Spine** has entered into an agreement to purchase **DePuy Synthes**' worldwide prodisc assets. The acquisition is expected to close in mid-4Q17. Upon completion, Centinel Spine will add cervical and lumbar artificial disc systems prodisc-C, prodisc-L, prodisc-C Vivo, prodisc-C Nova, prodisc-O

## Industry News [continued from page 16]

and Discover to its portfolio, which presently includes MIDLINE and STALIF interbody devices as well as ALTOS posterior cervical stabilization and the ACTILIF Cervical Cage. The acquisition also serves as a catalyst for Centinel's ex-U.S. expansion. The company has focused on the U.S. and Australian markets and plans to use the prodisc portfolio to launch into more ex-U.S. markets. For Centinel Spine, re-acquiring the technology was attractive because of prodisc's nearly 20 years of clinical history, plus the strength of the artificial disc market, which is estimated to grow at 16 percent to 20 percent worldwide for the next five to 10 years.

**Bone Biologics** (BB) entered into an exclusive license agreement with **UCLA** for global application of NELL-1/DBX recombinant human protein growth factor through a technology transfer. BB's initial focus for NELL-1 is as a bone graft substitute for spine fusion. Researchers are examining its ability to systemically restore bone and prevent further loss. BB has expanded its Field of Use definition in its license agreement with UCLA. In short, this refers to an agreement entered in 2006 that has since received numerous amendments. It provides BB with exclusive license to several UCLA patents covering enhanced NELL-1 bone mineralization. A 10th amendment granted BB the rights, after completing certain milestones, to negotiate an expanded Field of Use to include treatment of osteoporosis. As of May 2017, all milestones were met and negotiations commenced. Now, BB and UCLA will study the application of NELL-1 as a platform technology for use in spinal fusion, trauma and osteoporosis, focusing first on fusion. U.S. Food and Drug Administration guidance indicates that that NELL-1/DBX will be classified as a combination product, with a device lead.

According to a new market research report published by **MarketsandMarkets**,[1] the orthobiologics market is projected to reach $6.06 billion by 2022 from $4.66 billion in 2017, at a CAGR of 5.4 percent during the forecast period. The report analyzes and studies major drivers, restraints, opportunities and challenges of the orthobiologics market in North America, Europe, Asia Pacific and the rest of the world. Factors such as rising burden of orthopedic injuries; increasing incidence of sports injuries and road accidents; increasing incidence of spinal fusion surgeries; risk factors associated with increasing aging population, obesity rate and high incidence of musculoskeletal disorders; and growing patient preference for minimally invasive procedures are driving the orthobiologics market. However, high cost pertaining to orthobiologics-based treatment is the major factor restraining market growth to a certain extent.

**LifeLink Tissue Bank**, a division of LifeLink Foundation, Inc. headquartered in Tampa, Florida, announced a new partnership with Taiwan-based **HCT Regenerative** in which LifeLink will provide allografts for patients suffering from sports, orthopaedic or spine injuries. HCT Regenerative was established in July 2016 and is the first company in Taiwan to focus on processing human tissue to produce regenerative biomaterials for clinical use. LifeLink will procure and provide to HCT certain bone and tissue for HCT's use in its operations, while both parties will collaborate to assist HCT in the growth and development of its operations.
**Bone Therapeutics**, a bone cell therapy company based in Belgium, announced that it has signed an exclusive, royalty-bearing license agreement with one of Japan's leading industrial companies, **Asahi Kasei Corporation**. The license agreement covers the development and commercialization of Bone Therapeutics' autologous bone cell therapy product, PREOB, which is derived from bone marrow mesenchymal stem cells, in Japan. Under the terms of the agreement, Asahi Kasei will obtain exclusive rights to develop, register and commercialize PREOB for the treatment of osteonecrosis of the hip with the potential for other orthopaedic and bone applications in Japan. Bone Therapeutics will share its patented proprietary manufacturing expertise for the expansion and differentiation of stem cells into bone-forming cells in preparation for continued clinical development by Asahi Kasei in Japan. In addition, Bone Therapeutics has also granted Asahi Kasei an option to negotiate an exclusive license for the development and commercialization of PREOB in Korea, China and Taiwan.

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# Designing better biomaterial-based drug carrier systems that enhance therapeutic delivery to the diseased skin and its draining lymph nodes

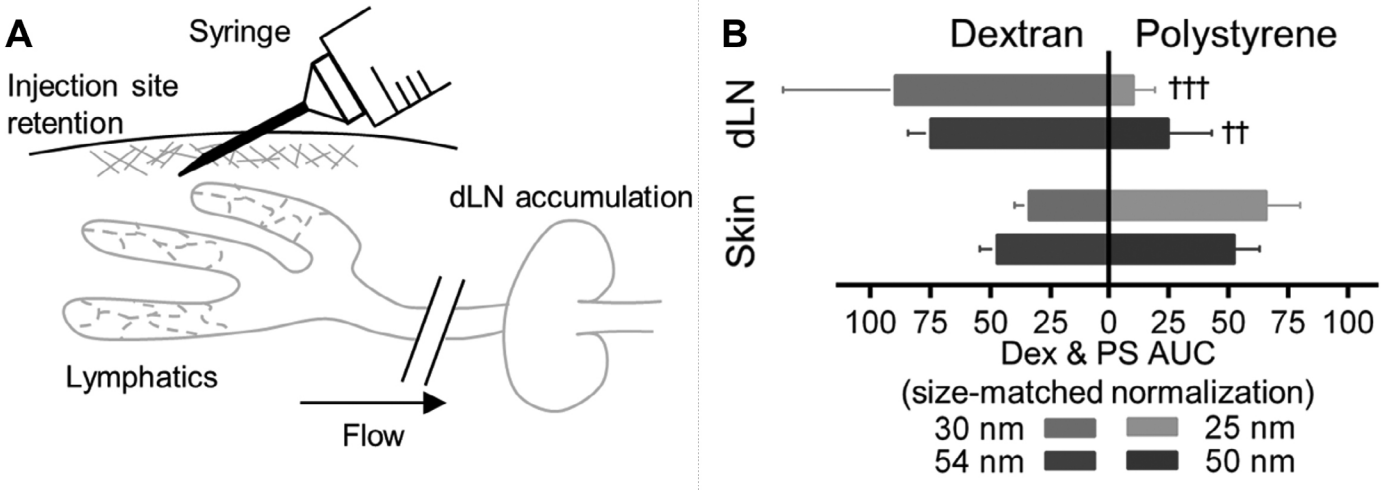
*By Susan N. Thomas, George W. Woodruff School of Mechanical Engineering, Parker H. Petit Institute of Bioengineering and Bioscience, Georgia Institute of Technology; Winship Cancer Institute of Emory University*

Strategies aiming to achieve locoregional immunomodulation are increasingly employed for the treatment of a variety of pathologies, such as cancer and autoimmune disease. Accordingly, biomaterial-based formulations have been explored to improve the bioactivity and therapeutic efficacy of numerous immunotherapeutic interventions[1-6]. New research in our laboratory is helping to further define biomaterial design criteria that improve drug bioavailability within the diseased skin as well as enable robust and facile therapeutic delivery to lymph nodes, high value tissue targets for immunotherapy applications ranging from regenerative medicine to vaccines and cancer therapy.

First, immunological signaling localized to both the skin and its draining lymph nodes is associated with a variety of skin pathologies. Therapeutic immunomodulation in either the skin or its draining lymph nodes or in both tissues simultaneously is potentially desirable for numerous therapeutic scenarios. Given the common use of direct injection techniques, we recently investigated *in vivo* the coupled effects of both hydrodynamic size and flexible macromolecular versus rigid spherical form on carrier transport after administration in the skin by implementing a panel of tracers comprised of polymers resistant to both hydrolysis and proteolytic degradation that span a size range of widely used drug carrier systems and are labeled with fluorophores with minimal tissue absorbance and spectral overlap[7]. Our results demonstrate that chain-like, flexible macromolecular but not rigid, spherical particulate retention within the skin injection site is size-dependent, that enrichment within the skin relative to systemic tissues increases with size for both macromolecules and particles, and macromolecules accumulate in draining lymph nodes more extensively and selectively than rigid, spherical particles (Figure 1). These results refine the current understanding of how drug carriers can be designed to enhance payload delivery to both skin and its draining lymph nodes.

Second, cancer immunotherapy has emerged as a successful treatment approach that induces durable objective responses in patients with advanced melanoma, albeit in only a minority of patients[8]. Numerous significant immune-related adverse events and toxicities associated with cancer immunotherapy also remain to be minimized[9]. In addition to efforts aiming to identify those patients most likely to benefit from immunotherapy using biomarkers, a variety of strategies are being developed to improve the efficacy and safety of cancer immunotherapy, including formulations that optimize drug accumulation and bioactivity within target tissues (tumors and their draining lymph nodes) while simultaneously minimizing exposure in off-target systemic tissues. Direct injection of therapeutics is now used for some melanoma treatments, such as oncolytic virus therapy. Progress in improving such therapies or applying

**Figure 1.**




Flexible macromolecules are retained at the site of injection at similar levels but accumulate in draining lymph nodes (A) at higher levels compared to size-matched, rigid particles (B).

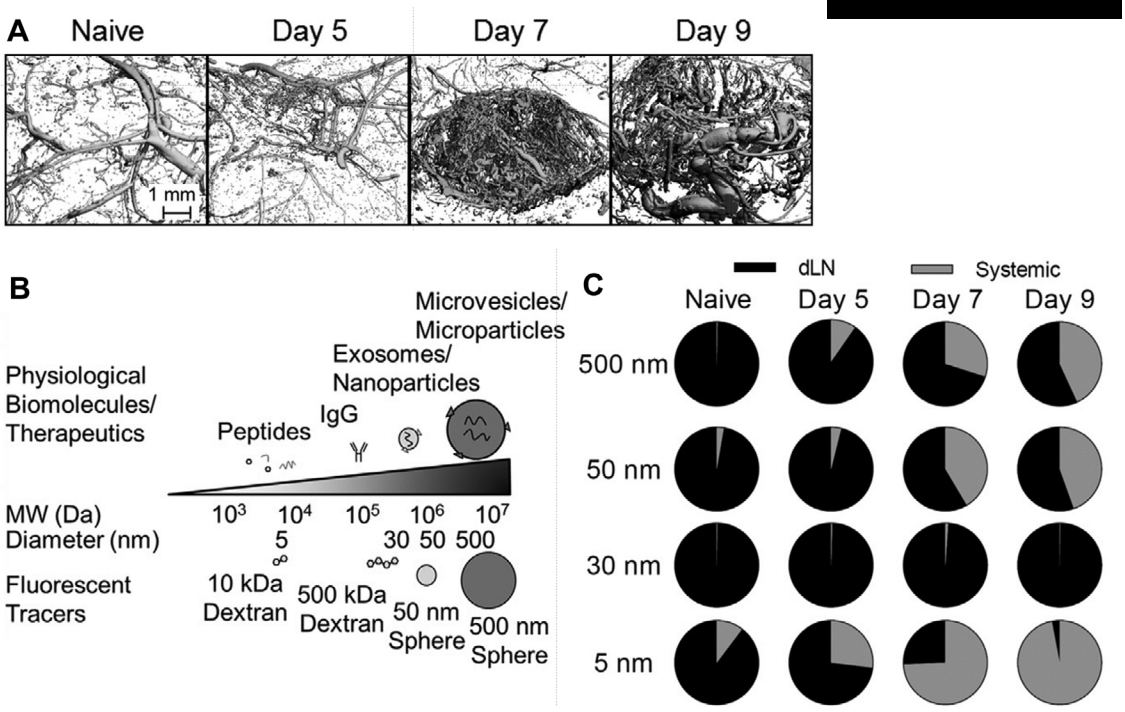



**Figure 1.**

Although tissue vascular remodeling during the course of disease progression (A) differentially influences the transport of macromolecules (B) injected into the tumor microenvironment to sentinel (tumor-draining) lymph nodes in a size-dependent manner, size-based principles of lymphatic-mediated lymph node delivery are conserved in melanomas (C).

this administration approach more broadly to other classes of therapeutics has been severely stymied by the limited understanding of how cancer onset and progression influence carrier retention and lymphatic uptake within the tumor.

To fill this knowledge gap and through the use of an advanced preclinical *in vivo* skin tumor (melanoma) model and biodistribution analyses leveraging a panel of near-infrared fluorescent tracers, we recently demonstrated that tumor progression differentially effects cell- versus fluid drainage-mediated lymphatic transport to attenuate the accumulation of factors derived from the tumor microenvironment in sentinel lymph nodes[10]. Importantly, our findings indicate for the first time that despite these changes, size-based principles of lymph node drug targeting[2,7,11,12] are conserved in melanomas, suggesting their applicability to sentinel lymph node-targeted drug delivery (Figure 2). In addition to these insights, this work contributes evidence that remodeling of the tumor vasculature that induces the enhanced permeability and retention effect in solid tumors, an effect which forms the basis of the tumor-directed nanomedicine field, may also result in leakage of factors derived from the tumor into systemically distributed tissues. These findings suggest that tumor vascular remodeling may therefore negatively contribute to disease progression by promoting the formation of pre-metastatic niches that aid in cancer's spread to distant tissues. Furthermore, our findings imply that serum biomarkers used to diagnose and/or stage disease in millions of patients annually worldwide may appear in the circulation not as a result of their overexpression by the tumor, but due to remodeling of the tumor vasculature.

This work has helped define drug delivery approaches to improve immunotherapeutic delivery to diseased skin and its draining lymph nodes using biomaterials. Ongoing studies will validate their relevance in *in vivo* models of therapeutic immunomodulation.

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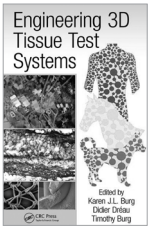
# Book Review

*By Lynne Jones*




*Engineering 3D Tissue Test Systems*
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Progress in tissue engineering has been predicated on advances in technology and in our knowledge of biological systems. While tissues are by nature 3D, historically, many of our test systems and analytical tools were 2D. Placing cells on top of biomaterials in cell culture plates was the norm. Then we learned that cells behaved differently when grown in gels, co-cultures (including transwell culture systems) or under varying mechanical conditions.

This book describes the transition from 2D test systems to 3D test systems, which has exponentially improved our understanding of cell–biomaterial interactions. The editors say it best themselves when defining 3D test systems as "biological models compromising cells and biomaterials that can be used to better understand normal and healthy processes to discover new drugs, vaccines and therapies and to assess new implant designs." The book contains 20 chapters ranging from basic science and engineering (bench) to the translation of this technology to medical applications (bedside). The authors of each chapter are highly respected in their fields, resulting in a book that is easy to follow that provides us with the background to understand cutting-edge technology.

Twenty chapters have been grouped into four sections: biofabrication considerations, materials considerations, biological considerations and business considerations. Chapter 1 introduces the book and its goals.

## SECTION I: BIOFABRICATION CONSIDERATIONS

Chapter 2 describes the basics of biofabrication (fabrication; design considerations) in a clear-cut manner that undergraduate students will find easy to comprehend; figures clearly illustrate key points. Chapter 3 reviews strategies for bioreactor design. This includes categorizing types of bioreactors (stirred-flask; rotating wall, perfusion and other) and types of stimulation (mechanical, electrical and electromagnetic). The sensing and control of bioreactor systems is also described. Chapter 4 is unique: It describes the evolution of a test system to address the limitations of an earlier model. Chapters 5 and 6 provide examples of biofabrication applications. Chapter 5 moves into the biological application with a study of a biofabricated adipose implant for nipple/breast reconstruction using fused deposition modeling, a 3D printing technique. Chapter 6 illustrates the use of spheroid/aggregate culture systems as applied to breast cancer. They demonstrate the feasibility of using an inkjet-based printing system for printing reproducible and high-throughput dispensing of 3D cell spheroid aggregates.

## SECTION II: MATERIALS CONSIDERATIONS

Chapter 7 covers the hot topic of polypropylene hernia mesh implants. The importance of using a material that is inert and biocompatible for implants that are considered permanent is stressed. Based on prior experience with these implants, improved quality control tests are recommended. Chapter 8 provides an up-to-date overview of scaffolds used for bone regeneration. The relevance of 3D model systems in the development of bone graft substitutes is noted. Different approaches to scaffold design and fabrication can be used to create a 3D environment on which to grow bone cells while being structurally competent. Chapter 9 aptly describes the development and anatomy of the human breast as well as the complexities of the native mammary tissue properties that an engineered composite should try to emulate. Different model systems are described, illustrating the importance of these 3D models to the study of healthy and diseased (cancerous) tissues. The chapter concludes with a technical example highlighting the use of a 3D composite system to evaluate the behavior of breast cancer cells in a 3D model of mammary tissue. Chapter 10 describes experimental models to study bone metastatic breast cancer. By simulating some of the conditions of the microenvironment (e.g., presence of HA or collagen), we can better understand tumor-cell−mineral interactions and also improve clinical strategies to interfere with bone metastasis.

Chapter 11 provides an overview of 3D scaffolds as applied to the reconstruction of cardiovascular tissues. Various common scaffolds are described: polydimethylsiloxane, synthetic hydrogel matrices, electrospun matrices and decellularized matrices. This chapter provides an excellent discussion of the importance of understanding the scaffold microenvironment, including surface properties and cellular adhesion, scaffold pore size, remodeling of extracellular matrix, cell-to-cell communication and mechanical properties.

## SECTION III: BIOLOGICAL CONSIDERATIONS

The next group of chapters develops our knowledge regarding the biological aspects of these systems, including the underlying fundamental cellular mechanisms of signaling of inflammatory cytokines (Chapter 12); cell–cell communication through gap junctions in cancer (Chapter 13); understanding stem cell behavior with respect to breast stem cells in healthy and diseased tissues (Chapters 14 and 15); a description of the

utility of free-floating mammosphere 3D system (Chapter 14); cardiovascular applications, including the promise of cell sheet engineering (Chapter 16); signaling and architectural (spatial arrangements) of multiple tissues involved in diabetic tissue (pancreas, liver, skeletal muscle and adipose) (Chapter 17); an overview of the cells and scaffolds used to develop engineered muscle (Chapter 18); and simulating the microenvironment of the glioblastoma multiforme as a realistic model of a diseased state (Chapter 19). Of note, Chapter 16 also addresses the limitations of 3D tissue systems. Chapter 19 also addresses the limitations of current 3D models for the brain and glioblastomas because of the diversity of signaling molecules in this highly controlled microenvironment.

## SECTION IV: BUSINESS CONSIDERATIONS

The last chapter (Chapter 20) is timely indeed, dealing with the coding of biofabricated materials. There is also an editors' note regarding the use of this technology for in vitro diagnostics. While regulation is briefly mentioned, it is suggested that the interested reader supplement his or her reading.[1,2]

There are books on cell culturing techniques and books on tissue engineering and regenerative medicine. This book has taken a different approach to tissue engineering; its focus is on the test system model used to develop new biomaterials and test new pharmaceuticals and biologics for tissue engineering and regenerative medicine. Each chapter in this book is unique and incorporates not only the facts but also the wisdom and opinions of the authors. The book addresses the study of the behavior of cells by mimicking the environment in which they may eventually be placed — whether it has a specific organizational structure or different cell types and cell signaling, or whether it is in healthy tissue or tissue in various disease states. Each chapter is packed with information and can be read as a standalone monograph. This book is an excellent resource for undergraduate students and for those just entering the field. The inclusion of several chapters dedicated to the fundamentals of different aspects of biofabrication followed by chapters with examples illustrating these fundamentals is an approach that will help novices to better understand the principles. However, the book is also a good read for more established investigators as a reminder of where we have come and where we are going regarding cell-seeded scaffolds and regenerative medicine.

## TABLE OF CONTENTS



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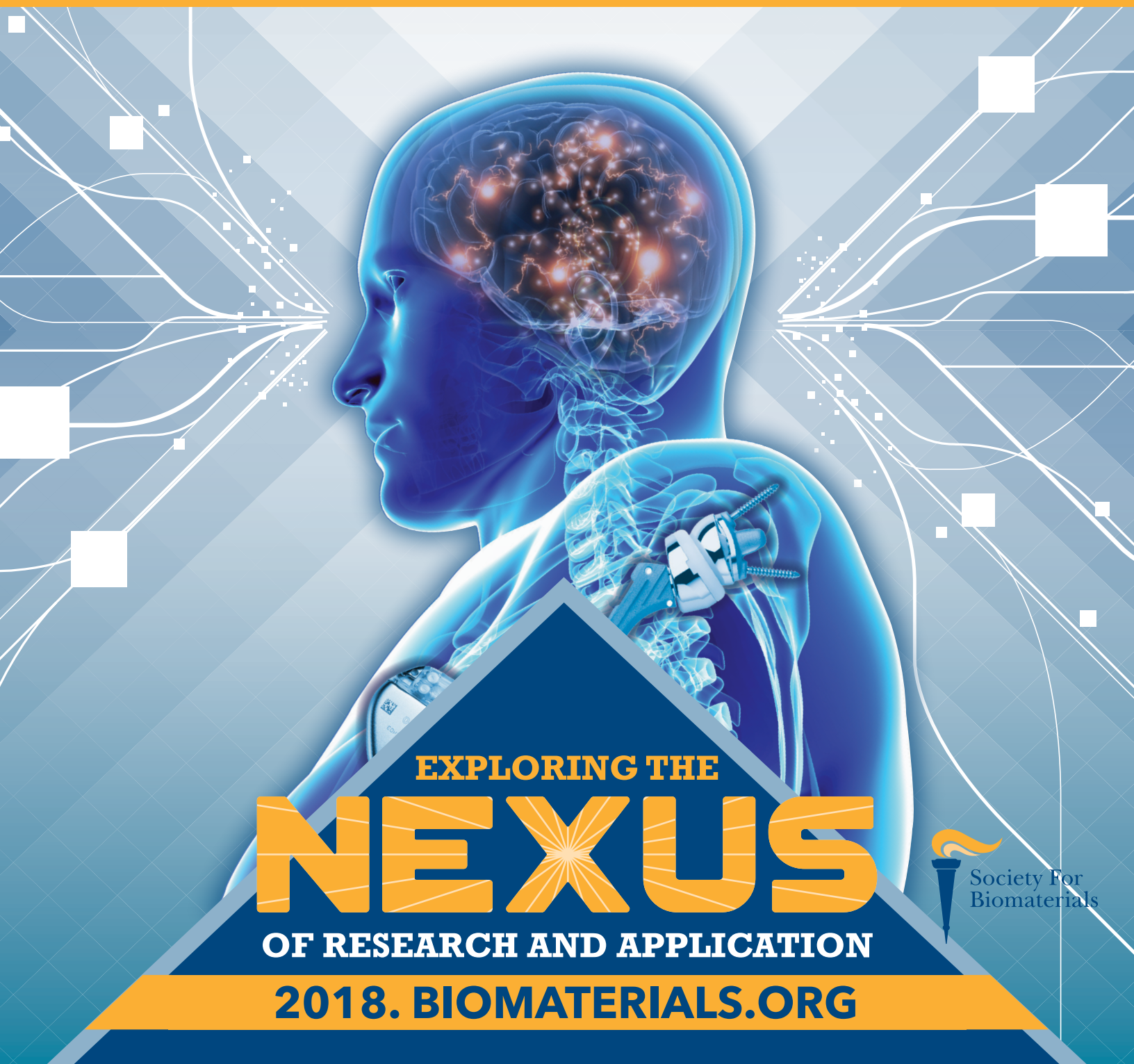

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