BIOMATERIALS FORUM

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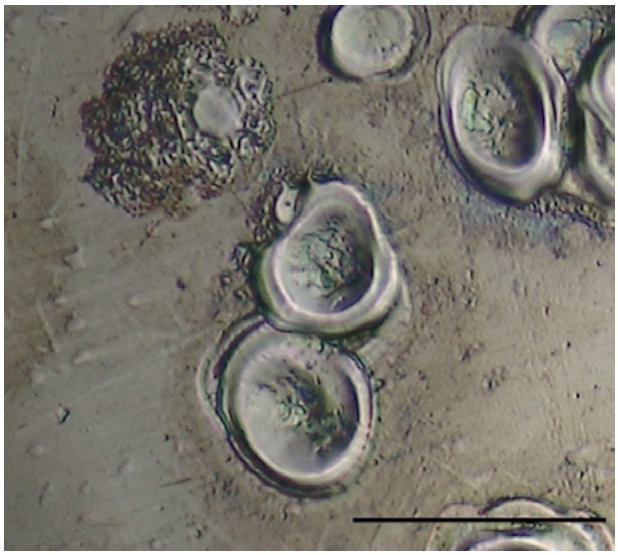
BIOMATERIALS
FORUM

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

Special Interest Group Reporters



Contents

The Torch

2 From the Editor

3 From the President

8 Staff Update

News & Updates

5 History
The Foundation for Society For Biomaterials

6 Opinion
The Tenth Question

10 Member News

12 Historical Flashback
Selective Luck Led One to Become a Pioneer in the Field of Biomaterials

13 New Approaches in Biomaterials
Two Novel Calcium Phosphate Precipitation Techniques

14 *Antioxidant Biomaterials Promote Healing By Combating Oxidative Damage*

16 SIG News
Biofunctional Relevance of Synthetic Mucin Mimics Formed by Affinity-Driven Filamentous Nanostructures

19 *News from the Surface Characterization & Modification SIG*

20 *News From The Biomaterials & Medical Product Commercialization (BMPC) SIG*

21 Student Chapter Update
Professional Development Opportunities for Students

22 Government News

22 New Journal of Interest

23 Industrial News

25 Education News
STEM Education and the Numbers Behind the Hype

27 Book Review: No Time to Die

29 Coming Up in 2015

On the cover: Digital optical micrograph of inflammatory cell induced corrosion attack of a CoCrMo metal-on-metal total hip replacement acetabular component. Inflammatory cells (from the phagocytic mononuclear cell line, e.g., osteoclasts, neutrophils, macrophages, and foreign body giant cells) have been demonstrated to attach to and directly corrode CoCrMo alloy implant surfaces in-vivo. These cells all generate oxidative burst-like reactions generating reactive oxygen species, and utilize Fenton reactions that can directly corrode CoCrMo alloys in vivo. Scale bar = 50 μm. Photo courtesy of Professor Jeremy Gilbert, Syracuse University.

GREETINGS FELLOW BIOMATERIALS SCIENTISTS,

As I compiled the content from the various editors for this issue of the Society For *Biomaterials (SFB) Forum*, I realized once again what a special group of members we have in the SFB and how fascinating the world of biomaterials is. Our members have a great depth of knowledge that they are applying to solve the health problems of the world; most importantly they are willing to take the time to share that knowledge through this publication and others. While our annual meeting only occurs once a year, you can keep up to speed on the latest in biomaterials by reading the *Forum* or by browsing the SFB website. The *Forum* is a great way to find out what your colleagues have been doing and to discover how various areas of biomaterials research are progressing from a multipronged perspective: academic, industrial, clinical, and governmental.

- The Government News article in this issue features an announcement about a Cell Manufacturing Consortium that is being planned by the Georgia Research Alliance and funded by the National Institute of Standards and Technology to help establish the United States as the leader in cell manufacturing technology. The goal of the consortium, with nine founding partners from across the country, is to "establish a collaborative public-private partnership that engages industry, academia, regulators, and other stakeholders in removing barriers to the advancement of the cell-manufacturing industry, thereby bringing new therapies and diagnostics to the healthcare market."

- The Surface Characterization & Modification (SC&M) Special Interest Group (SIG) contributed a short technical article and two other SFB members share their recent contributions to the field of biomaterials in short technical articles as well. General updates from both the Biomaterials & Medical Product Commercialization SIG and the SC&M SIG are found in this issue. Getting involved with a SIG is a great way to establish contacts with colleagues who share the same subspecialty interests, and as a means to influence scientific programming at the annual meeting.

- This issue's Historical Flashback column contains a reflection from Dr. Jonathan Black, SFB founding member and Past President, about what we've learned, or haven't learned, over the past 20 years from studying the clinical outcomes of orthopaedic devices such as total hips or knees.

- Be sure to read Industrial News for an overview of the latest product releases, mergers and acquisitions, regulatory issues, job outlooks, and other notable corporate achievements or concerns. It may provide some direction or guidance for your next endeavor.

- Student Chapter President, Jordon Gilmore presents an advice-packed Student News column aimed at graduating students. His message is that there's no time like the present for professional development.

- Our SFB members continue to receive prestigious professional awards and advancements, and move on to other new opportunities. Read Member News to learn more and be inspired by what your colleagues have achieved.

- I recently read a fun book on a long airplane flight that made the time speed by. Most of the main characters in the book are research scientists and entrepreneurs! And yet the book is a thriller/murder mystery. Hard to imagine that combination, but that's the case in *"No Time to Die."* See the Book Review on the last few pages of this issue to learn more.

Please help us to make sure this publication continues to reflect news of interest about the diverse and fascinating field of biomaterials by contributing a short technical article or opinion piece. Send your draft articles or any questions about content to me at **Lkuhn@uchc.edu**.

See you soon in April at the annual meeting!

Best wishes,

LIISA KUHN, PhD
Biomaterials Forum Executive Editor
Associate Professor
University of Connecticut Health Center

For as long as I can remember, the students in the Society For Biomaterials (SFB) have had a considerable role in helping our Society evolve into an internationally renowned organization. While attending the meetings in the late 1980s and 90s, it was evident to me that students and fellows gave many, if not most, of the presentations in the plenary sessions. This is still true today at our annual meetings. As the years have passed, students have become more involved in various aspects of the Society, including development of The National Student Section of SFB, involvement in the Special Interest Groups (SIGs), and social interactions at the annual meeting. However, the Society can do more for our students. Years ago, when I was attending one of the annual business meetings of the Society, Professor Bob Baier from the University of Buffalo remarked that "We need to engage our students, as they are the life and blood of this organization." I recall those words from Dr. Baier, not only at that business meeting, but at others, because this is still an important issue today. In this letter, I would like to update you on some initiatives the Society has been working on over the past year to promote more student involvement and engagement. I also suggest some ideas for the future of our Society based on engaging our students, as well as what is perhaps a forgotten group, our fellows and postdoctoral fellows.

An important concern is attracting students to our Society during their tenure, not only as students, but also when they transition to an academic, governmental, or industrial positions. Students have organized a number of student chapters and this number has appreciably risen in the last five years, perhaps due to the many initiatives put forth, such as Biomaterials Days or the Biomaterials Education Challenge. We currently have 29 student chapters in the United States with 478 student members in these chapters. Local student chapters must comprise at least three student SFB members to remain active. Our most recent data indicates that 10 of the 29 local student chapters have less than the required three student SFB members and eight chapters have only three student SFB members. These numbers are surprisingly low and may be due to local chapter laws, but I believe we can increase the number of student SFB members. One way of doing this is through an initiative being discussed by the Membership Committee, chaired by Dr. Kurt Kasper, to implement a plan offering a discount on each current student's SFB membership fee, as well as incentivizing our student chapters to increase membership. This is a sound approach, as it presents minimal fiscal risk, provides reduced fees to join an organization for students, strengthens our student chapters, and brings more money and more members to our Society. In the short term, our membership increases, but I would hope that as students transition in their careers, they remember how our Society provided support during their lean early years. This offer of some financial support, albeit small, asserts that our Society is supportive and appreciative to students, and we would hope that they would consider full-time membership as they enter their new (and hopefully more lucrative) careers. This plan seems to be a win-win situation, benefitting both our students and our Society.

> *"We need to engage our students, as they are the* **life** *and* **blood** *of this organization."*
>
> **—Bob Baier**
> **Professor from the University of Buffalo, annual business meeting of SFB**

Our Biomaterials Days have been a success since Dr. Lynne Jones introduced this program during her service as President of the Society. The Biomaterials Days, more often than not, are co-sponsored by multiple institutions, with the student chapters directing the entire program. Most of the programs have an industry component, such as an industry panel discussion; some have had appreciable industry financial support. The Society currently supports six different Biomaterials Days; the plan for 2015 and beyond is to expand this program to seven or more sites. There are some concerns that will need to be addressed in the coming years, including fiscal support and what institutions will receive that support. We

should strongly encourage our student chapters who have not had a Biomaterials Day to contact other institutions and industries in their region and consider hosting one. This is an excellent experience for the student members and is an opportunity to bring our community of scientists from academia and industry together in a particular region. If we can increase our student membership and then increase the number of student chapters, we can begin to think about having more Biomaterials Days. It is also time to review the impact of Biomaterials Days; this will be brought to the Long Range Planning Committee chaired by Dr. Thomas Webster, our President-Elect.

The Education and Professional Development Committee, chaired by Dr. Tim Topoleski, has been meeting this year and discussing a plan to improve mentoring within our Society. Our Society has already done some mentoring by hosting the student/academia/government/industry luncheons at our annual meeting. This format gives students a chance to meet with academic, government, and industry members. Having participated in this event, I believe this has been a huge success and should continue. However, we can do more to help mentor our undergraduate and graduate students, as well as what I call a forgotten group, our postdocs, fellows, and junior associates. These groups of former students would benefit from some further mentoring in such areas as manuscript and grant preparation, journal and grant reviewing, regulatory issues, and mentoring on transitioning to a new position, whether in academia, industry, or government.

About three years ago, during Dr. Joel Bumgardner's Presidency, the Biomaterial Education Challenge was initiated and has been very successful. This program has generated a number of various interesting projects that have been presented at our annual meetings. The projects were targeted mostly to middle school or high school students to promote biomedical engineering principles and/or exposure to biomaterials research. Again, the Education and Professional Development Committee is working on how to organize this information so it can be promoted on our website, as well as distributed and/or marketed to K-12 schools throughout the country. This is a very good idea, as it promotes an interest in science to our youth, and gives our Society positive publicity in local communities.

Professor Baier's comment about our students being the life and blood of our organization still rings true. I think about how good a society or organization is and would contend that, as a student, I would remember an organization that strongly supported me. I encourage our academic members to emphasize to their students and postdoctoral fellows that membership in our Society is valuable. I strongly encourage our members in industry and government to indicate to their junior associates the same. We can only grow and sustain our robust organization by having an engaged membership and I encourage you to offer any ideas, suggestions or comments as to how this can be done, now and in the future of the Society For Biomaterials. Please contact me at **npz@case.edu**.

NICHOLAS P. ZIATS, PhD
Case Western Reserve University
President, Society For Biomaterials

"We can only **grow** *and* **sustain** *our robust organization by having an engaged membership"*

—Nicholas P. Ziats, PhD
Case Western Reserve University
President, Society for Biomaterials

The Foundation for Society For Biomaterials (SFB)

In 1969, a number of researchers in the biomaterials field initiated a series of International Biomaterials Symposia, concentrating predominantly on materials for reconstructive surgery. As these symposia became increasingly popular, the idea to establish a dedicated biomaterials organization germinated. The Society For Biomaterials (SFB) was formally established in April 1974.

The purpose for the formation of SFB was, and remains today:

- To encourage, foster, promote, and advance research, development, and education in biomaterials sciences
- To promote, initiate, support, and accomplish cooperative research, development, and educational programs in this field in the public interest

The initial Board of Directors was composed of Dr. C. William Hall, Dr. Samuel F. Hulbert, Dr. Sumner N. Levine, Dr. Sigmund A. Wesolowski, and Dr. Richard S. Woodbury, and the inaugural annual meeting of SFB was held April 26, 1975, at Clemson University in Clemson, South Carolina. The Society recognized its founder Dr. C. William Hall with both an annual award and a scholarship in his name.

By 1980, the First International Congress of Biomaterials was held in Vienna, Austria.

SFB is the oldest scientific organization in the field of biomaterials and has enjoyed tremendous growth and success over the years. In order to stay on the cutting-edge of the ever-changing, fast-paced field of biomaterials, SFB supports 14 Special Interest Groups (SIGs), whose purpose is to provide a forum for networking and new ideas within a focused environment. SFB also cultivates student chapters at many universities.

The Society continues to be the world leader in the field of biomaterials by organizing an annual meeting in the United States and by participating in the quadrennial World Biomaterials Congress. These meetings are designed for industry, academia, and clinicians to gather and discuss the latest trends and scientific breakthroughs pertinent to the field of biomaterials.

Since its founding in 1974, the Society has been "giving life to a world of materials."

For more visit **biomaterials.org.**

Presidents of participating societies included [standing from the left] Jean Leray (France), Larry Hench (U.S.), David Williams (U.K.), Frank Cooke (U.S.), Adam Wesolov (U.S.), unknown, Thomas Salthouse (unknown), Larry Katz (unknown), [seated from left] unknown, George Winters, C. William Hall and Samuel Hulbert.

The Tenth Question

JONATHAN BLACK, PHD, FBSE, CHARTER SFB MEMBER AND PAST PRESIDENT, AND PROFESSOR EMERITUS OF BIOENGINEERING, CLEMSON UNIVERSITY

SOME REFLECTIONS ON THE 2005 BANANA CORP. (BA) – INVENTOR CONSULTANTS' MEETING†

As I sat in the meeting sessions that last month of 2005,* I reflected on the past. The past year saw two important milestones for a dear friend of mine, Mr. Robin Ling. December 2005 was marked by the 35th anniversary of his first surgical procedure with what became known as the Exeter Hip, as well as the sale of the 500,000th Exeter femoral stem. I thought about my long acquaintance with him, of spending time in Exeter, U.K., in 1978, and of our many subsequent encounters.

More recently, as I mulled over what I had heard and not heard at that meeting years ago, some questions came to mind. I had read the Second Annual Report of the National Joint Registry for England and Wales[1] and been reminded that the U.K. National Institute for Clinical Excellence (NICE) had established measurement benchmarks for evaluation of total hip replacement outcomes at 3 and 10 years post-operative. Thus my thoughts turned back to 1995.

In 1995:

- Newt Gingrich was Speaker of the House and Bob Dole was Senate Majority Leader.
- Bill Clinton was the 42nd President, nearing the end of his first term.
- The Murrah Federal Building in Oklahoma City was bombed, with 168 people killed.
- O.J. Simpson was acquitted of the charge of murdering his former wife, Nicole Simpson, and her friend, Ron Goldman.
- The Federal highway speed limit of 55 mph was repealed.
- The national unemployment rate averaged 5.6 percent.
- The San Francisco 49ers beat the San Diego Chargers 49-26 in Super Bowl XXIX and the Atlanta Braves took the World Series 4-2 over Cleveland.

Here are some questions I had about total hip replacement and BA in 1995:

[1] What were the demographics of U.S. patients who received *BA* products that year? How many were there and how were they distributed by gender, height, weight, diagnosis, and health status?

[2] What were their hopes and aspirations before the procedure? And how well were these met in the short, intermediate, and long term?

[3] What *BA* devices were sold in the United States (and how many of each variation)?

[4] How did surgeons decide which *BA* device was appropriate for each patient? And what would they have liked (but did not have) for primaries? For revisions?

[5] What surgical procedures, anesthesia regimens, rehabilitation programs, and pre- and post-operative pain control measures were in use?

[6] How many patients had subsequent procedures on the replaced joint or others, or have died (and for what reasons)?

[7] How many *BA* devices remain in use and what happened to the rest?

[8] For *BA* devices that were removed, what was their condition and how was it related to their removal?

[9] What are the interrelationships between the answers to these questions? How do these compare to the experience for devices manufactured by others and for those that *BA* sold outside the United States that year?

On reflection, in 2005, I failed to hear answers to any of these (and other related) questions.Which brings me to the tenth question:

[10] In 2015, 10 years on, what will we know about the "class" of 2005?

† *Banana Corp. (BA) is a fictitous device manufacturer name inserted to keep the identity of the manufacturer in question anonymous.*

The Spanish philosopher Jorge Santayana remarked, "Those who cannot remember the past are condemned to repeat it."[2] What would he say about those who do not know their own history and thus cannot be expected to learn from it? And, for that matter, what about total knee replacement?

I had emphasized three themes in my advice to BA in 2005:

- In the short term, simplify surgery such that average surgeons can be consistently good enough.
- In the intermediate term, recognize that implant and instrument technology are already good enough and focus on human factors, concerning both patients and surgeons, to seek improved outcomes and satisfaction.
- In the long term, understand that the emerging revolution in biomedicine, especially regenerative medicine, will radically alter the approach to joint disease and disability.

While these views still seem appropriate, I remain concerned that lack of knowledge of the past and present clinical experience with Banana's and competitor's products will become an increasingly insurmountable barrier to evolutionary, let alone revolutionary (disruptive), change and improvement. If BA and others continue to conduct their business as previously conducted, I fear that the answer to the tenth question will be, "No more than about the class of 1995."

Postscript

It is clear that these comments, written in the context of the conduct of a single U.S. orthopaedic implant manufacturer, apply equally well to all of their competitors and, in fact, to nearly all U.S. manufacturers of surgical implants and other durable medical devices. The adverse public health and financial consequences of this lack of "vital statistics" concerning medical devices, on which so many Americans depend, were obvious in 2005 and remain so today.

** December, 2005. These reflections were written in January 2006; slightly revised for publication October 2014.*

REFERENCES

1. National Joint Registry for England and Wales, 2nd Annual Report. http://www.njrcentre.org.uk/njrcentre/portals/0/documents/england/reports/njr_ar_2.pdf. Published September 2005.
2. Santayana, George (Jorge). *The Life of Reason, Vol. 1.* C Scribner's sons; 1905-6.

Staff Update

BY DAN LEMYRE

Dan Lemyre, SFB Executive Director

Deb Dupnik, SFB Assistant Executive Director

Hello from Society For Biomaterials (SFB) headquarters! I am writing the Staff Update for the first time in several years because of a change in personnel. Leslie Clark has gone on to serve the American Society for Transplantation as their Executive Director. We wish her every success in her new position, and thank her for her service to SFB. It is my distinct pleasure to announce that we have hired a new Assistant Executive Director who is already getting up to speed. Please join me in welcoming Deb Dupnik to the SFB headquarters staff.

Deb holds a B.S. in Microbiology from the University of New Hampshire and was ASCP certified. She is married with two daughters (her oldest is an architect and the youngest just graduated with a degree in Biomedical Engineering). Deb has been with Association Headquarters for 5 years serving a few different clients during her tenure here, but has reported that with her new role at SFB, she has finally found a home that engages her passion for science.

In other news, preparations for 2015 and beyond are well underway. The Annual Meeting, budget preparation, and great new possibilities for collaboration in 2016 are all issues that will have been discussed by the Society Board of Directors and Governing Council at their Nov. 6, 2014 meeting. The Society's Board of Directors, governing council, committees, task forces, and Special Interest Groups (SIGs) will be working to advance the Society's mission as described here.

AWARDS, CEREMONIES AND NOMINATIONS
CHAIR JAMES M. ANDERSON, MD, PhD

The Awards, Ceremonies and Nominations Committee has received 34 award nominations and 11 nominations for the three open officer positions. Pending Council's ratification to the proposed slate, award winners and officer candidates will have been announced in November. Thank you to all those who made nominations, and please start thinking about possible nominations for next year!

BYLAWS
CHAIR ANN SALAMONE, PhD

The Bylaws Committee is discussing some suggestions made to changes in the Society's governance structure, including the length of the President's term, the possible addition of a second member at large, and changes to the composition of the Finance Committee. Their recommendations will also be reviewed by the Council before they solicit support for any proposed changes.

DEVICES AND MATERIALS COMMITTEE
CHAIR SHROJAL DESAI, PhD

The committee is actively supporting the second SFB Business Plan Competition, which was developed by the Biomaterials & Medical Products Commercialization SIG, and is working to organize a third workshop in collaboration with the Chinese Society For Biomaterials (CSB), in conjunction with the CSB 2015 meeting in Haikou, China.

EDUCATION & PROFESSIONAL DEVELOPMENT
CHAIR TIM TOPOLESKI, PhD

The E&PD Committee is soliciting applications for the 2015 C. William Hall Scholarship. They are currently evaluating grant applications for the 2015 Biomaterials Day program. In addition, the committee is developing several new initiatives, including a series of webinars, programs in mentorship, K-12 outreach, and a course content/curricula sharing portal on the SFB website.

Undergraduate students interested in attending the SFB Annual Meeting should apply for the C. William Hall scholarship. This award honors the memory of the Society's first president, Dr. C. William Hall. The recipient of the this scholarship will have all of his or her expenses paid for participation in the SFB 2015 Annual Meeting, including airfare, hotel, transfers, registration, and meals. (Some limitations apply.)

FINANCE
CHAIR LISA FRIIS, PhD

Development of the 2015 budget is underway. In 2014, SFB invested in a new website, and provided the inclusion of a free SIG for each member. SFB is also expanding the Biomaterials Day grant program to even more institutions. Reserves remain healthy, and the Finance Committee is looking to invest in increasing membership services.

LIAISON
CHAIR DAVID PULEO, PhD

The Liaison Committee continues its efforts to coordinate and collaborate with other societies. We are pursuing interactions with domestic and international organizations encompassing engineering, life, and clinical sciences. A concerted effort is being made to develop collaborative programming in 2016 in hopes that we can bring

the tremendous experience of the SFB membership to work together with other organizations. The committee has solicited proposals to this end, and will be making a recommendation to the Council for opportunities to pursue in 2016.

LONG RANGE PLANNING
CHAIR THOMAS WEBSTER, PhD

The committee is investigating methods to increase participation from industry members, extend the Society's reach into the clinical community, and provide additional member services in career development and resource sharing.

MEETINGS
CHAIR NICHOLAS ZIATS, PhD

The 2015 Annual Meeting will take place in Charlotte, North Carolina, on April 15-18, 2015. The committee is making a recommendation to the Board for the 2015 Bash, and is in the process of venue selection for the 2017 and 2018 Annual Meetings.

MEMBERSHIP
F. KURTIS KASPER

The committee has evaluated the results of a recently conducted lapsed member survey. Key issues include how to retain members, how to continue to evolve to meet the needs of a changing field without losing our unique identity, and how to increase the value of membership. The committee is also proposing a new program to increase participation from SFB's 29 student chapters. While the Biomaterials Days program has helped to increase activity at many chapters, student engagement and membership in the Society lags slightly behind. The membership committee's proposal will be evaluated by the Board at the upcoming meeting.

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

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PROGRAM
CO-CHAIRS PETER EDELMAN, PhD, AND HELEN LU, PhD

The 2015 Program Committee received 87 ideas for sessions at the 2015 meeting in Charlotte, North Carolina. From that, a total of 77 proposals were requested. The SIGs once again participated in the review of proposals, in addition to a review by the program committee. Dr. Anthony Atala (Wake Forest Institute for Regenerative Medicine) will deliver the keynote address. In addition to the presentation of abstracts and several panel discussions, the program will feature two competitions for students: the Business Plan Competition and the Education Competition. Please visit the meeting website at 2015.biomaterials.org for the most up-to-date information on the 2015 meeting.

PUBLICATIONS
CHAIR ALAN LITSKY, MD, ScD

The Publications Committee was instrumental in developing the new SFB website in 2014, and continues its work with the bi-weekly e-newsletter, *Biomaterials Bulletin.* In addition, the committee will be working to expand services available on the website, and will look to continue SFB's partnership with Wiley Blackwell in the publication of the *Journal of Biomedical Materials Research.*

NATIONAL STUDENT CHAPTERS
PRESIDENT JORDON GILMORE

National Student Chapter officers will be working to organize a student mentoring lunch and a career fair at the 2015 Annual Meeting in Charlotte, North Carolina. In addition, efforts by the Membership Committee are underway to increase the SFB student member base and keep them engaged through their transition to their professional careers.

SPECIAL INTEREST GROUPS
REPRESENTATIVE STEVE LITTLE, PhD

In 2014, each SFB member received a complimentary SIG membership, and this is planned to continue. The publication of the SIGnal newsletter also continues on a monthly basis. The SIG officer elections will be held very early in 2015, and a call for nominations will have gone out in late November. Please consider the SIGs as a great place to get more involved with the Society and to grow your personal and professional networks!

Members in the News

BY HORST VON RECUM, 2014-15 MEMBER-AT-LARGE

Greetings members! I have enjoyed hearing from you all this past quarter. As a reminder, in my role as Member-at-Large, I represent you, the overall members of the Society For Biomaterials (SFB). In this capacity, I serve as an unencumbered representative of the members on both the Board of Directors and the Council of the Society. In this representative role, I am a member of other SFB committees (Long Range Planning Committee, Bylaws Committee, Membership Committee, and Program Committee). As such, I hope I have a clear voice in the direction of the Society, and that my participation in these committees and governing bodies ensures all voices can be heard. I continue to encourage all members to bring forth ideas about the Society, meetings, and anything else relevant to making SFB better. This forum is a great way to catch up on what is happening in our community and see how SFB members are impacting the field. Please send your news for future issues! As usual, SFB members have been very active and productive in the past quarter.

Dr. Jordan Green, Associate Professor in Biomedical Engineering at Johns Hopkins University, was selected as one of *Popular Science*'s "Brilliant Ten" for 2014. His lab works within the chemistry/biology/engineering interface to answer fundamental scientific questions, and to create innovative technologies and therapeutics that can directly benefit human health. His work highlighted in *Popular Science* is on the design of biomimetic artificial antigen presenting cells for immunobioengineering.

Dr. Green and **Dr. Horst von Recum,** Associate Professor in Biomedical Engineering at Case Western Reserve University, were each individually selected for the pilot of the NIH's I-Corps program, a new entrepreneurship program for translational medicine. Nineteen teams were chosen across all of the NIH. It is a unique honor that two of those teams were headed by SFB regulars.

SFB member **Dr. Christine Schmidt,** Pruitt Family Professor and Chair of Biomedical Engineering at the University of Florida, was recently elected Chair-Elect of the College of Fellows for the American Institute for Medical and Biological Engineering (AIMBE). Dr. Schmidt's research is focused on engineering novel materials and therapeutic systems to stimulate damaged peripheral and spinal neurons to regenerate.

Dr. Karen Burg, Past President of the Society and long-time member, has two announcements this quarter. First, Dr. Burg was elected as one of seven members of the inaugural class of the American Association for the Advancement of Science (AAAS) - Lemelson invention ambassadors. The ambassadors program launched July 1, 2014 at the AAAS in Washington D.C. Each member of the class was asked to give a very personal story, describing when the mundane turned to a moment of innovation. See youtube.com/watch?v=UgIaNzpjOBo to watch her presentation.

Dr. Burg's other big news is that she recently departed from Clemson University to accept her new position at Kansas State University, where she is Professor of Chemical Engineering and Vice President for Research. At Clemson, Burg had been the Hunter Endowed Chair, Professor of Bioengineering, and had directed the Institute for Biological Interfaces of Engineering. From 2007 to 2011 she was Clemson's interim Vice Provost for research and innovation. Her research is on novel absorbable polymeric systems, including applications in orthopedic and dental devices, as well as assessment models using magnetic resonance imaging and cell adhesion.

Dr. Sarah Stabenfeldt, Assistant Professor, School of Biological and Health Systems Engineering, Arizona State University, just received an NIH Director's New Innovator Award (DP2) titled, "Detecting and treating traumatic brain injury pathology progression from the inside out." Her research focuses on detecting and treating traumatic brain injury via molecular recognition and targeting strategies.

Dr. James Anderson, Distinguished University Professor of Pathology, Macromolecular Science, and Biomedical Engineering of Case Western Reserve University, was recently given the 2014 European Society of Biomaterials (ESB) International Award. The International Award is a prestigious recognition by the ESB of scientists who have spent their career outside of Europe, who have a widely recognized, high-scientific profile, have made major contributions to the field of biomaterials, and have shown strong evidence of collaborations with members of the European scientific community throughout their career. Dr. Anderson is a long-standing member and Past President of SFB. His research efforts are centered on the development of a better understanding of blood and tissue/material interactions as they relate to implantable devices and biomaterials. The overall focus of his efforts is on the cellular and humoral responses to implanted

materials. Studies currently ongoing include an analysis of the wound-healing response to vascular graft materials, in vivo biocompatibility testing with the focus on macrophage and foreign body giant cell adhesion and activation, and a determination of those factors which lead to the biodegradation of biomaterials.

Dr. Cato T. Laurencin, Van Dusen Distinguished Professor of Orthopaedic Surgery from the University of Connecticut (UConn Health), has won a National Institutes of Health Pioneer Award for his exceptionally creative research in regenerative engineering. The $4 million grant is part of NIH's program for high-risk research with potentially high rewards. It will support his cutting-edge work in regenerative engineering, a new field he has described in the journal *Science Translational Medicine.* The NIH Director's Pioneer Award recognizes an exclusive class of individual scientists whose work is deemed exceptionally creative, highly innovative, and to have the potential to produce "unusually high impact" in addressing or solving "exceptionally important problems" in biomedical or behavioral sciences. In the 11-year history of the Pioneer Award, relatively few recipients are also practicing physicians, like Dr. Laurencin, who take research findings from the lab to the bedside.

Dr. David Mills, Professor, Biological Sciences and Biomedical Engineering from Louisiana Tech University; President of organicNANO, and CEO of Southern Biomedical Products, was recently highlighted for his group's work in 3D printing. His research program is focused on designing novel and dynamic nanofilms (biodegradable, bioactive, micropatterned) for cell adhesion, differentiation and functionality, nanomaterials for dental and orthopedic implants, layer-by-layer assembly for cell encapsulation, nanoparticle-based drug delivery, anti-infective nanofilms, 3D printing of bioactive biomedical materials, application of nanoscale topographic and chemical cues for controlling chondro- and osteogenesis, structure-function relationships in TMJ soft tissues, and engineering tissues for TMJ repair or replacement. His is a diverse group with researchers from across the globe, including China, Costa Rica, India, Iran, and the United States.

Dr. Jeffrey Karp, Associate Professor at Harvard Medical School and Co-Director of the Center for Regenerative Therapeutics at the Brigham and Women's Hospital recently shared in a TEDMED talk about his unexpected insights into the field of bio-inspiration; and the art and science of adapting medical tools, treatments, and technologies from solutions found in nature. Dr. Karp's research focuses on stem cell engineering, biomaterials, and medical devices inspired by nature. He has many inventions to his name, including slug-inspired tissue glues, parasitic worm-inspired microneedles, jellyfish-inspired cell-sorting chips, and a gecko-inspired medical tape. Jeff's other innovations include a novel neonatal skin adhesive and a nanoparticle prophylactic approach to prevent contact dermatitis. Jeff is an acclaimed mentor and is most proud of the 13 trainees he has launched into faculty careers around the globe.

Dr. Rebecca A. Bader, Associate Professor, Department of Biomedical and Chemical Engineering from Syracuse University, continues to be competitive at Ironman triathlons and marathons, while working on her research and teaching, including a recent second-place overall finish at the Washington, D.C., Rock n' Roll marathon. She also recently qualified for the Ironman world championships. In addition to outstanding athletics, Dr. Bader has developed an extramurally funded research program focused on 1). synthesizing carrier systems for pharmaceutical applications from natural and synthetic polymers for cancer, as well as diseases associated with inflammation, such as rheumatoid arthritis and cystic fibrosis and 2). developing innovative methods to evaluate the performance of novel treatment strategies, particularly targeting drug delivery systems using in vitro models of disease.

Dr. Chao Zhong, a new Assistant Professor at Shanghai Tech University, and former postdoc at MIT recently had a paper published in *Nature Nanotechnology* titled, "Strong underwater adhesives made by self-assembling multi-protein fibers." His Integrative Bio-inspired Molecular Engineering (IBME) group will continue to leverage the power of synthetic biology to engineer new bio-inspired materials and nanobiotechnology.

Selective Luck Led One to Become a Pioneer in the Field of Biomaterials

Historical Flashback

BY GUIGEN ZHANG, CLEMSON UNIVERSITY

Dr. Jack Lemons in his younger days.

For this issue's Historical Flashback, I asked Dr. Jack Lemons of the University of Alabama at Birmingham to give us some of his perspectives from his association with Society For Biomaterials. Jack was the president of SFB from 1987 to 1988 and he was also the winner of 1991 Clemson Award for Applied Research. Interestingly, Jack has a direct tie with Clemson University in the earlier days of the birth of the field of biomaterials.

Jack has reflected about opportunities and changes over past decades since being a faculty member at Clemson during 1969-70, which had led to many opinions; in his belief, they were "not always correct, but never in doubt." Considering the outcomes from the decisions made, he felt "selective luck." He explains:

"I was very lucky to have been a small part of the dynamics going on in The Division of Interdisciplinary Studies led by Sam Hulbert. For me, it was the correct group and correct interactions to set me into a pathway that I continue today. I often call this period the Golden Years of Biomaterials Development.

I sincerely regretted leaving Clemson, but the call of an NIH-funded Special Fellowship in Medicine and Dentistry (five years of clinical participation as a student) could not be declined. My wife said, after a decade of being a student — you get a job — and now you want to be a student again. This again, was selective luck, in that I/we found an equally acceptable situation in Birmingham at UAB.

Looking forward from my perspective of an ever-growing discipline, I envy those who can now obtain measurements at the levels of atomic dimensions and chemistries (the nano-world). Perhaps when we revisit those early publications, we will be able to determine more of the basic mechanisms of the interactions at the tissue interfaces. I have always been amazed how well many of those early biomaterials actually performed — they did as intended. Also, as I evaluate in situ/en bloc device to tissue interfaces after decades of function in humans from post mortem donors — many of our theories were correct."

Dr. Lemons plans to provide a review of some of these thoughts in a 20-minute presentation at the 2015 SFB meeting. For those who are keen to get such a unique historical overview, you will not want to miss it.

Two Novel Calcium Phosphate Precipitation Techniques

New Approaches in Biomaterials

BY A. CUNEYT TAS, PHD, FORMER PROFESSOR OF BIOMEDICAL ENGINEERING AT YEDITEPE UNIVERSITY, ISTANBUL, CURRENT VISITING SCIENTIST AT THE DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING OF THE UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Society For Biomaterials (SFB) member Dr. Tas recently reported the novel use of two biomineralization solutions to separately synthesize monodisperse nanospheres of X-ray-amorphous calcium phosphate (ACP) and an apatite-like calcium phosphate with an extraordinary BET surface area of 900 m^2/g. The first biomineralization medium was a completely inorganic solution with ion concentrations mimicking those of the DMEM cell culture solutions, named as BM-7[1] or DMEM-i.[2] The second biomineralization medium, depicted in the below table for preparing 1 L in deionized water, was a Tris-buffered synthetic body fluid (SBF) solution with a HCO_3 concentration of 27 mM (identical in value to that of the human blood plasma) and 125 mM Cl^- concentration.[3,4]

Chemical (g/L)	DMEM-i[2]	SBF[3]
NaCl	4.787	6.547
KCl	0.397	0.373
$MgCl_2 \cdot 6H_2O$	0.166	0.305
$CaCl_2 \cdot 2H_2O$	0.332	0.368
$NaHCO_3$	3.701	2.268
$NaH_2PO_4 \cdot H_2O$	0.125	–
$Na_2HPO_4 \cdot 2H_2O$	–	0.178
Na_2SO_4	–	0.071
$(CH_2OH)_3CNH_2$	–	6.057

Amorphous nanosphere synthesis: DMEM-i solution was simply stirred and heated at 65°C for 1 hour. Autogenously forming ACP nanospheres were separated from the solution by membrane filtration, followed by drying at 37°C.[2] Although numerous methods are known to produce irregular-shaped ACP particles, this approach led to the synthesis of monodisperse nanospheres (175 nm diameter, 185 m^2/g BET surface area) for the first time (Figure 1). ACP nanospheres may serve as biocompatible drug or biomolecule carriers in a number of oncological or pharmaceutical applications. The simplicity of ACP synthesis[2,5] is promising.

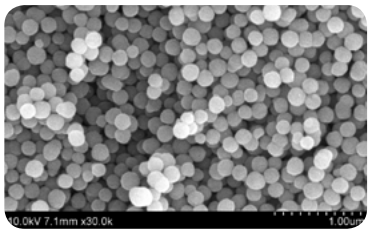

Figure 1. (FE-SEM): ACP nanospheres synthesized in DMEM-i.[2]

Apatitic CaP synthesis: The Tris-buffered synthetic body fluid (SBF) solution with a HCO_3 concentration of 27 mM, when refrigerated at +4°C in sealed glass bottles (non-agitated) over periods from 1 to 4 months, autogenously formed hydrated, carbonated apatitic calcium phosphate precipitates, which were found (upon lyophilization) to possess BET surface areas in the vicinity of 900 m^2/g, regardless of the aging time (Figure 2).[3] Such high surface area biocompatible calcium phosphates may be useful in drug delivery and in orthopedic/maxillofacial bone tissue regeneration applications.

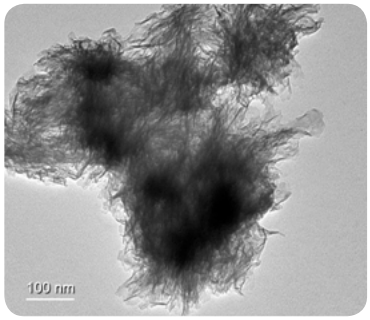

Figure 2. Transmission electron micrograph (TEM) of hydrated, carbonated apatitic CaP with a surface area of 900 m2/g.[3]

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Antioxidant Biomaterials Promote Healing By Combating Oxidative Damage

BY AMANDA MORRIS, NORTHWESTERN UNIVERSITY

Created by a team led by Guillermo Ameer, Professor of Biomedical Engineering and Surgery in Northwestern's McCormick School of Engineering and Applied Science and the Department of Surgery, Feinberg School of Medicine, the first-ever inherently antioxidant biomaterial has the potential to prevent failure in medical devices and surgical implants.

When a foreign material like a medical device or surgical implant is placed inside the human body, there is always a response. "You will always get an inflammatory response to some degree," said Ameer. "A problem with commonly used plastic materials, in particular, is that in addition to that inflammatory response, oxidation occurs." According to Guillermo Ameer, most of the time that response can be negative and affect device function.

We all need oxygen to survive, but a high concentration of oxygen in the body can cause oxidative reactions to fall out of balance, overwhelming the body's natural antioxidant defense system, leading to oxidative stress. This oxidative stress modifies natural proteins, cells, and lipids and causes them to function abnormally, which can contribute to chronic disease, chronic inflammation, and other complications that may cause the failure of implants. Thus, biomaterials that can counter the effects of oxidative stress in a sustained manner are needed.

For the first time ever, Ameer and his team have created a biodegradable biomaterial that is inherently antioxidant. The material can be used to create elastomers, liquids that turn to gels, or solids for building devices that are more compatible with cells and tissue.

"Plastics can self-oxidize and create radicals, as part of their degradation process," Ameer said. "By implanting devices made from plastics, the oxidation process can injure nearby cells, and it creates a cascade that leads to chronic inflammation. Our materials could significantly reduce the inflammatory response that we typically see."

In the first study, published in the June 26, 2014 issue of *Biomaterials*,[1] Ameer created a polydiolcitrate that incorporates vitamin C as part of its polyester network. The resulting material can scavenge free radicals, chelate metal ions and inhibit the lipid peroxidation process, as well as protect cells from oxidative stress (Figure 1A). In preliminary experiments, Ameer's team also coated vascular grafts with the antioxidant biomaterial and the grafts were evaluated in animals by his long-term collaborator in vascular surgery, Dr. Kibbe, and her team. As part of the foreign body response, grafts tend to inflame nearby cells and slowly scar over time, which eventually leads to failure. When the antioxidant vascular graft was implanted, however, the scar was significantly reduced (Figure 1B).

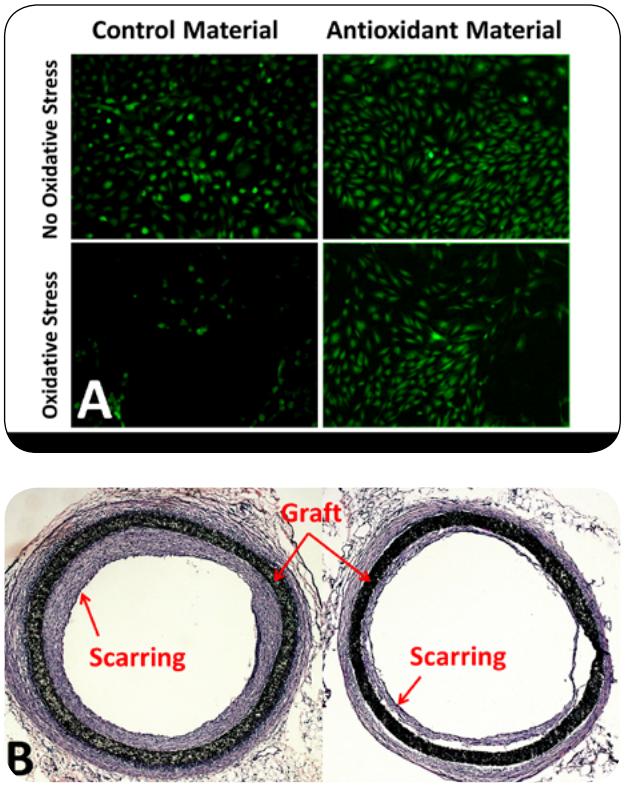

Figure 1. When endothelial cells are exposed to oxidative stress, the intrinsically antioxidant polyester elastomer, incorporating citric acid and vitamin C protects the cells, which retain high viability (A). A cross-section of a prosthetic vascular graft coated with this material demonstrates reduced scarring (B).[1]

In another study, funded in part by a proof-of-concept grant from Northwestern University Clinical and Translational Sciences Institute (NUCATS), Ameer's team developed a water-soluble, thermoresponsive polyester with antioxidant properties that contains citric acid, but no vitamin C (Figure 2). In that research, recently described in the journal *Biomacromolecules*, the authors show that this injectable biomaterial can safely and efficiently entrap and deliver therapeutics, such as growth factors and cells.

The thermoresponsive polyester, referred to as Nanonets™, is harmlessly absorbed by the body over time. Nanonets™ and variations of it are currently being investigated for wound-healing and cardiovascular-regenerative engineering applications.

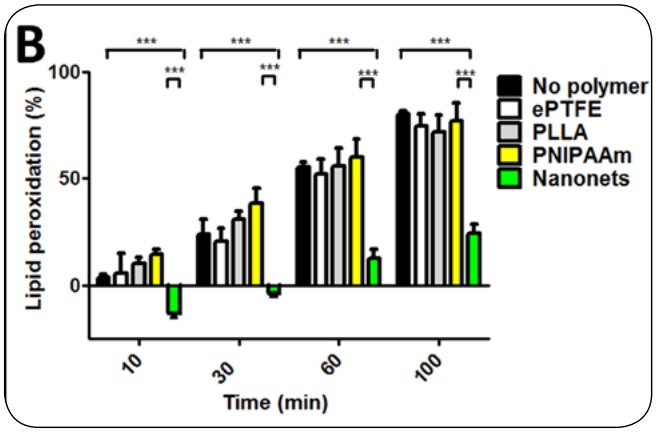

Figure 2. An injectable thermoresponsive polymer was engineered to have intrinsic antioxidant properties. The material, referred to as Nanonets™, gels at 37°C (A) and significantly inhibits lipid peroxidation, unlike commonly used materials such as polytetrafluoroethylene (ePTFE), poly(L-lactic acid) (PLLA), and poly(N isopropylacrylamide) (PNIPAAm) (B).[2]

"In the past, people have added antioxidant vitamins to a polymer and blended it in," Ameer said. "That can affect the mechanical properties of the material, limiting how much antioxidant you can add so it doesn't work well. What we're doing is different. We're building materials that are already inherently, intrinsically antioxidant."

Ameer said the new biomaterials could be used to create scaffolds for tissue engineering, coat or build safer medical devices, promote healing in regenerative medicine, and protect cells, genes, and viruses during drug delivery. In addition to applications in medicine, these intrinsically antioxidant materials could potentially also be used in other fields where oxidative damage is a concern, such as in the cosmetics and food industries. He added that the new biomaterials are easy to make and inexpensive.

"Citric acid is affordable and in pretty much everything we come in contact with on a daily basis — food and beverage, skin and hair products, drugs, etc. It's a common, inexpensive raw material to use and, in our system, can stabilize vitamin C, an antioxidant that we are all familiar with," he said. The first author of the *Biomaterials* study was Robert van Lith, Ph.D., and on the *Biomacromolecules* study Ameer shared first authorship with Jian Yang, PhD.

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Biofunctional Relevance of Synthetic Mucin Mimics Formed by Affinity-Driven Filamentous Nanostructures

BY SUNDAR P. AUTHIMOOLAM, DEPARTMENT OF CHEMICAL AND MATERIALS ENGINEERING, COLLEGE OF ENGINEERING, UNIVERSITY OF KENTUCKY; THOMAS D. DZIUBLA, DEPARTMENT OF CHEMICAL AND MATERIALS ENGINEERING, COLLEGE OF ENGINEERING, UNIVERSITY OF KENTUCKY; AND NIHAR M. SHAH, DEPARTMENT OF CHEMICAL AND MATERIALS ENGINEERING, COLLEGE OF ENGINEERING, UNIVERSITY OF KENTUCKY, AND BLUEGRASS ADVANCED MATERIALS, LLC, MEMBERS OF THE SURFACE CHARACTERIZATION AND MODIFICATION SIG

INTRODUCTION

Many naturally occurring molecules, such as collagen and mucin, undergo hierarchical self-organization processes, typically driven by a wide variety of molecular forces (e.g., ionic, hydrophobic, and hydrogen bonding), to form higher ordered structural aggregates.[1,2] In the human body, mucin networks form over mucosal surfaces (e.g., buccal, respiratory, gastrointestinal, and vaginal) through a multi-level complexation of mucin glycoproteins. Mucin networks are widely studied in literature for their role in mucoadhesion and their impact on drug transport and bioavailability across mucosal surfaces.[3] More importantly, the mucin networks play a critical role in human physiology by providing surface lubricity and hydration, regulating microbial adherence, and serving as a selectively permeable barrier.[4] The complexities associated with dynamic network formation and reformation, coupled with the broad variety of molecular forces involved, pose a huge challenge to researchers in understanding the behavior of bulk mucin networks.[5]

Inspired by such natural processes, Authimoolam et al developed a biomimetic mucin network using layer-by-layer (LBL) depositions of filamentous polymer micelles (filomicelles), as illustrated in their recent publication in *Biomacromolecules*.[1] The higher order association between filomicelle structures, similar to those observed between natural glycoprotein chains, was achieved through affinity driven biotin-streptavidin interactions (Figure 1a). Such a versatile mucin model (synthetic mucin network) can serve to decouple the effects of individual network properties, such as mucin charge, porosity, and thickness on bulk network behavior. This understanding can be used to predict the role of mucin networks in various biological functions, such as drug carrier (nanoparticle) permeation and mucin-biomolecule interactions. Additionally, by utilizing drug-encapsulated micelles, the described synthetic mucin networks can form functional bioactive interfaces with the capability for localized payload delivery.

FORMATION OF SYNTHETIC MUCIN NETWORKS BY LAYER-BY-LAYER DEPOSITION

Biotin-functionalized filomicelles (Biotin-FM) and spherical micelles (Biotin-SM) were synthesized using amphiphilic poly(ethylene glycol)-block-poly(lactic acid) (PEG-b-PLA) diblock copolymers. The transition of the micelles from spherical to filamentous morphology was controlled by tuning the degree of amphiphilicity of the polymeric diblocks, i.e., the relative hydrophilic to hydrophobic block lengths (Figure 1b). The micelles were loaded with curcumin, a model antimicrobial drug and a fluorophore to facilitate imaging (Figure 1c). Synthetic mucin networks were grown on surfaces by a controlled alternating deposition of streptavidin and biotinylated-micelles (Figure 2a).[6] Biotin-FM with their high-structural aspect ratio (length vs. diameter typically >20) was able to more readily crosslink than biotin-SM, thus forming dense 3D networks on both biological (rat dermal tissue, Figure 2b) and synthetic (polystyrene, Figure 2c). It should be noted that in the absence of either biotin (micelles without biotin) or streptavidin network formation did not occur, suggesting the key role played by the affinity linkages during network formation.

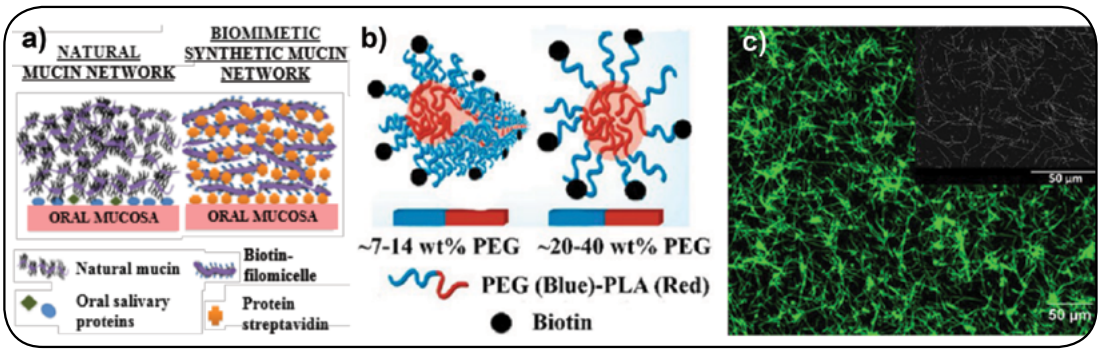

Figure 1. a) The overall scheme adopted to develop the synthetic mucin biomimics through affinity-driven crosslinking chemistry. b) Filamentous vs. spherical morphology of micelles controlled by degree of amphiphilicity i.e., the relative PEG to PLA block lengths. c) Fluorescence micrographs of curcumin-encapsulated biotinylated-filomicelles that were used as the building blocks for layer-by-layer deposition (inset shows scanning electron micrograph of filomicelles). *Figure reproduced with permission from Authimoolam et al,* Biomacromolecules, *2014. © American Chemical Society.*

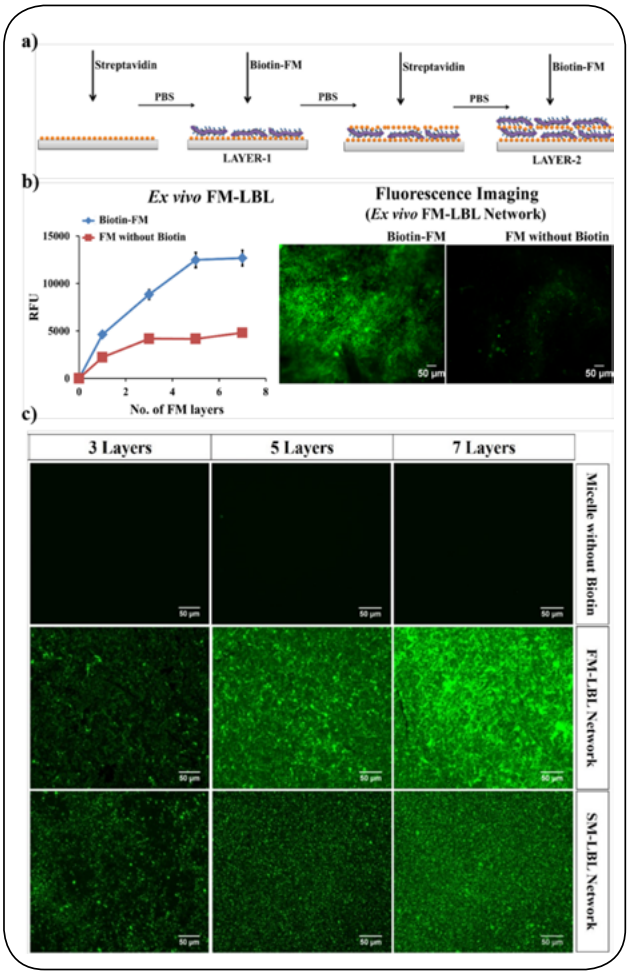

Figure 2. a) Illustration of synthetic mucin network formation by LBL deposition. b) Formation of FM-LBL networks ex vivo on rat dermal tissue. Network formation was studied by tracking the increase in relative fluorescence unit (RFU) from curcumin-loaded micelles with increasing LBL depositions. Also, a network formation was verified under fluorescence microscopy. The fluorescence micrograph shows network formed by 7 LBL depositions. Filomicelles without biotin were unable to form affinity linkages and hence could not crosslink into networks. c) Fluorescent micrographs showing the effect of biotin, micelle morphology and LBL deposition cycles on network formation on polystyrene surfaces. Curcumin loaded into all micelles served as the fluorophore for imaging. Top Row: Filomicelles without biotin were unable to form affinity linkages and hence could not crosslink into networks. Middle Row: Biotin-filomicelles crosslinked to form continuous 3D networks, with surface coverage increasing with the number of layers. Bottom Row: Biotin-SM formed a discontinuous coat on the surface that did not resemble a 3D network. *Figure reproduced with permission from Authimoolam et al,* Biomacromolecules, *2014. © American Chemical Society.*

STRUCTURAL CHARACTERISTICS OF SYNTHETIC MUCIN NETWORKS

During the LBL deposition process, the layers expanded laterally and vertically into a 3D network. At the initial stage, "islands" of micellar-aggregates were observed on the surface (left-most column in Figure 2c). However, at a higher number of deposition layers the high-structural aspect ratio of biotin-FM resulted in continuous networks with homogeneous substrate coverage (≈100 percent coverage) (right-most column in Figure 2c). This network formation mechanism is similar to that observed for natural mucin layers.[7] The vertical growth of the synthetic mucin networks was tracked by measuring thickness change using fluorescence confocal microscopy, wherein linear growth was observed with increasing LBL deposition cycles. The synthetic networks reach a thickness of about 4 μm at 7 layers (Figure 3a). At a higher magnification, the biotin-FM synthetic mucin network morphology resembled a nanoporous reticulated mesh with pore size ranging from about 110 nm to 340 nm (Figure 3b). Interestingly, this size scale is in congruence with pore sizes observed in natural mucin networks (~20-200 nm in cervical mucus).[8] Although surface coverage increases with number of layers for biotin-SM as well, the formed networks did not appear continuous and the surface coverage was inhomogeneous. Thus, synthetic mucin networks of the desired thickness ranging from nano- to micro-length scales can be developed using this facile LBL approach. Additionally, by controlling polymer properties (e.g., charge and hydrophilicity), networks with specific surface properties can be fabricated.

BIOFUNCTIONAL SURFACE PROPERTIES OF SYNTHETIC MUCIN NETWORKS

Among many biofunctional properties of mucin networks, their physiological role in providing surface lubrication and hydration are more readily perceived (e.g., mucin networks keep the oral, ocular, and respiratory regions moist). Specifically in the buccal cavity, loss of such hydration culminates into a painful inflammatory condition called xerostomia (or dry mouth).[9] Structurally, mucin glycoproteins are rich in oligosaccharide groups decorated around a polypeptide backbone. At interfacial regions, the polypeptide chains adhere to the mucosal epithelium, allowing the oligosaccharide chains to extend outwards thus forming a hydrated layer. Analogically, in the described synthetic mucin networks, the pre-assembled filomicelle structures contain hydrophilic PEG outer chains. Expectedly, the degree of surface wettability (hydrophilicity) increased rapidly with increasing number of layer depositions (Figure 3c). For instance, 7-layered biotin-FM networks possessed a contact angle of 29 degrees, significantly lower than the 90 degrees observed for the unmodified surfaces (Figure 3c).

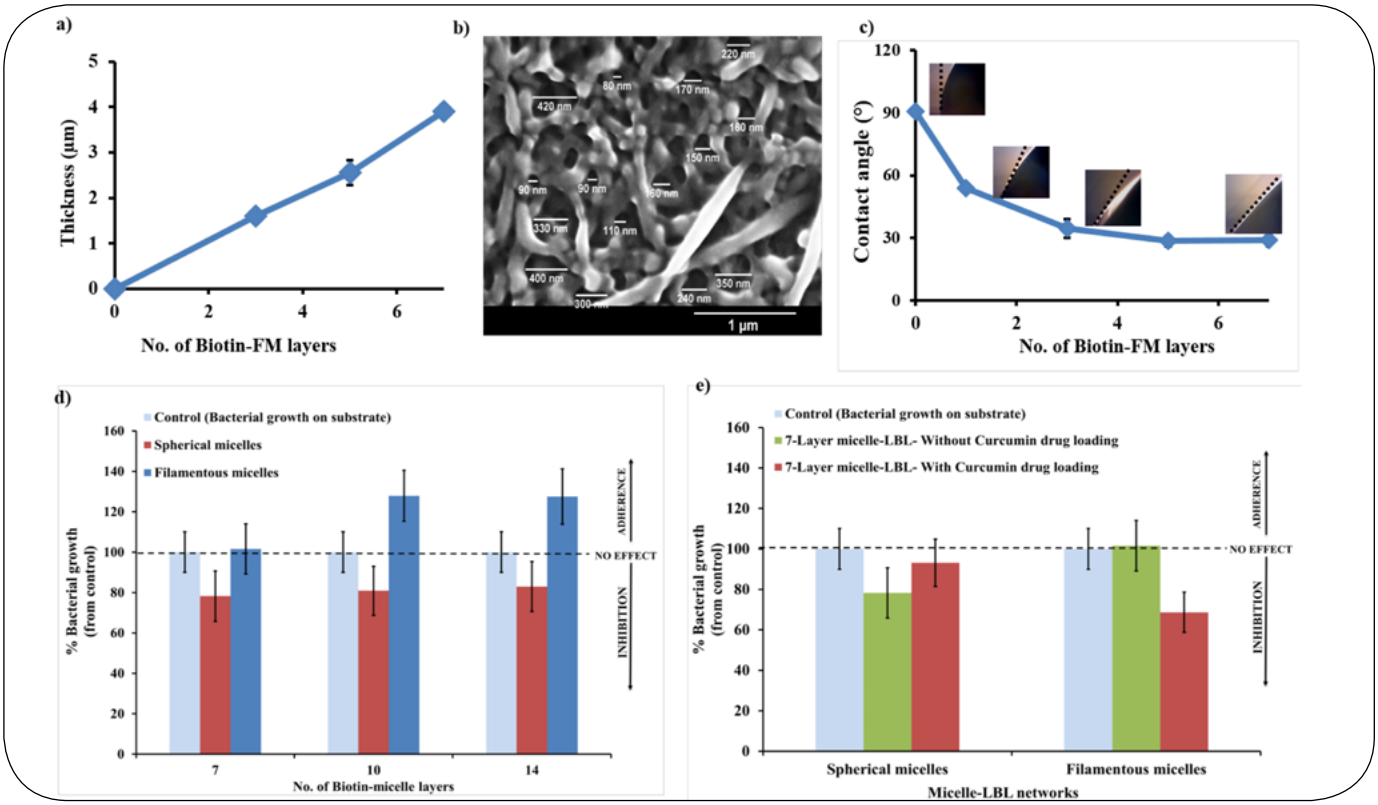

Figure 3. Biomimetic tendency of synthetic mucin networks. a) Network thickness increased linearly with increasing LBL deposition cycles, suggesting vertical network growth. b) Synthetic mucin networks resembling nanoporous reticulated networks, with average mesh size of about 110-340 nm. c) Water contact angle measurements showed a marked improvement in surface wettability with increasing number of LBL deposition cycles. d) Bacterial adherence studies in spherical and filamentous micelle-LBL networks without antimicrobial drug, curcumin. Results show a marked increase in bacterial adherence owing to its porous network morphology in filomicelle-LBL networks. Control surfaces were polystyrene. e) Bacterial growth on SM- and FM-LBL networks loaded with curcumin. Results show a marked decrease in bacterial growth due to the antimicrobial effects of curcumin. A much higher suppression of bacterial growth on FM-LBL networks likely stems from the relatively higher drug loading in the filomicelles compared to spherical micelles. Control surfaces were polystyrene. *Figure reproduced with permission from Authimoolam et al,* Biomacromolecules, *2014. © American Chemical Society.*

BACTERIAL GROWTH ON BIOMIMETIC MUCIN NETWORKS

In addition to their lubricating and hydrating properties, mucins also serve to control the type and number of microbial organisms that colonize the oral cavity.[10] First and foremost, the mucin network acts as a physical barrier that controls the entry of microbes into the underlying epithelium. Additionally, the mucin network presents specific binding domains that promote adhesion of certain microbes, while preventing adhesion of others. Finally, the continuous production and flow of salivary mucin flushes out excessive microbes, thereby regulating its growth. Analogous to natural mucin networks, the synthetic filomicelle networks (without drug loading) present hydrophilic PEG chains that are known to form non-adhesive surface layers. Despite the presence of PEG, the synthetic FM networks allowed bacterial adhesion (Figure 3d), probably due to their porous morphology and presence of other adhesion-promoting chemical moieties (e.g., biotin, streptavidin, PLA). However, when these networks were made with curcumin-loaded filomicelles, bacterial growth was significantly suppressed, resulting from the antibacterial effects of curcumin release (Figure 3e). These results indicate the biomimetic tendency of the synthetic mucin networks by permitting bacterial adhesion, but also illustrate its ability to provide localized therapeutic drug release.

SUMMARY

The formation of mucin networks as observed naturally was recreated via a synthetic approach using self-organizing FM nanostructures via highly specific affinity linkages. The physical characteristics of the synthetic network, such as morphology, pore size, and hydrophilicity, resembled those of natural mucin networks. More importantly, the synthetic networks were able to support bacterial adhesion similar to natural mucin. Their physical characteristics (e.g., thickness, and pore size) can be modified independently of its chemical properties (e.g., binding sites, chemical groups, and charged moieties). These synthetic mucin networks can not only help improve our understanding of physico-chemical characteristics and interfacial interactions of natural mucin networks, but also function as drug-delivery vehicles for therapeutic applications.

News from the Surface Characterization & Modification SIG

BY NIHAR SHAH, SC&M SIG REPORTER

The Surface Characterization & Modification (SC&M) Special Interest Group (SIG) is focused on promoting research and awareness about surface characterization and modification of biomaterials and medical devices. Surface properties, because of their inherent molecular origins, are often overlooked in biomaterials development, and if not designed properly can lead to failure of medical devices. Therefore, this SIG emphasizes two major research topics: 1). improving understanding of biomaterial surface structure and its relationship to biological performance, and 2). developing surface modification strategies for biomaterials. We currently have 170 members in our SIG, many of whom actively participate in the Society For Biomaterials (SFB) Annual Meeting as session organizers, session chairs, and abstract reviewers, as well as oral talk and poster presenters. SC&M SIG members represent a broad spectrum of professionals from academia, small businesses, large corporations, and government organizations.

At the 2014 meeting in Denver, the SC&M SIG sponsored 10 sessions spread across the entire multi-day meeting schedule. These sessions focused on Ophthalmic Biomaterials, Surface Modification of Bulk- and Nano-Biomaterials, Advances in Three Dimensional Scaffolds, Cardiovascular Biomaterials and Blood Compatibility, and Engineering Biomaterial Surface Topography for Tissue Repair. This high level of participation across meeting activities highlights the importance of this area of research. At the SIG's annual breakfast meeting, ideas and suggestions were considered for potential sessions that our SIG could sponsor for next year's conference in Charlotte, North Carolina. The main suggestion was for organizing a workshop on surface characterization, to be led by Drs. David Castner and Lara Gamble from the University of Washington Seattle. The workshop would cover the fundamentals of surface characterization techniques and a discussion on cutting-edge methods. Other suggestions included another workshop on surface modification and general session on biofilms and FDA requirements for the surface analysis of biomaterials. The SC&M SIG also plans to co-sponsor other sessions on topics of mutual interest with other SIGs.

"At the 2014 meeting in Denver, the SC&M SIG sponsored 10 sessions spread across the entire multi-day meeting schedule."

This SIG also believes in the career development of students, recent graduates, and early-stage researchers. Until 2013, every year we have sponsored and prepared a resume CD that is distributed to members of the medical device and pharmaceutical industries. This CD serves as a gateway that opens opportunities for young researchers and facilitates access to high-quality talent for hiring companies. Although the resume CD was not implemented for 2014, the SIG is planning to bring it back for 2015.

News From The Biomaterials & Medical Product Commercialization (BMPC) SIG

BY NIHAR SHAH, BMPC SIG REPORTER

Commercializing a new biomaterial or medical product goes well beyond the scientific research and development that occurs on the lab bench in an academic setting. Academicians and new entrepreneurs in this space encounter a number of additional challenges unique to medical devices and pharmaceuticals, including, but not limited to, regulatory approval, clinical trials, intellectual property protection, patent costs, litigation, manufacturing scale up, and marketing. The Biomaterials & Medical Product Commercialization (BMPC) Special Interest Group (SIG) serves as a forum to promote translation and commercialization of novel technologies arising from academic labs. SIG members interact and exchange information on these and related issues, providing a forum to assist Society For Biomaterials (SFB) members in preparing for and dealing with the commercialization of products. We currently have 282 members in our SIG, many of whom actively participate in the SFB Annual Meeting as session organizers, session chairs, and abstract reviewers, as well as oral talk and poster presenters. BMPC SIG members represent a broad spectrum of professionals from academia, small businesses, large corporations, and government organizations. We are striving to increase participation in this SIG, and to also organize more workshops and sessions dealing with commercialization for biomaterials and medical devices.

At the 2014 meeting in Denver, Dr. Anne Meyer, a member of the BMPC SIG, received the SFB Award for Service. The BMPC SIG was the primary sponsor of a first-ever Business Plan Competition. Six teams were chosen to present their business plan with a 10-minute executive summary followed by a "Shark Tank" style Q&A session. Technologies were presented related to surgery, cancer diagnostics, wound healing, organ transplant, drug delivery, therapeutics, vaccine storage, orthopedics, and cardiovascular medicine. The audience actively participated in judging the business plan presentations. Michael Zimkowski from the University of Colorado, Denver won the Judges' Award (sponsored by Tepha, Inc.) for MemMesh, a novel-shape, memory-functional surgical mesh. Suzanne Tabbaa from Clemson University won the Audience Award (sponsored by Dow Corning Corp.) for MetastaticPrecision, a rapid cancer diagnostic tool. The Business Plan Competition, again sponsored by the BMPC SIG, will return at the 2015 SFB Annual Conference in Charlotte, North Carolina.

"We currently have 282 members in our SIG, many of whom actively participate in the SFB Annual Meeting as session organizers, session chairs, and abstract reviewers, as well as oral talk and poster presenters."

BY JORDON GILMORE, CLEMSON UNIVERSITY, NATIONAL STUDENT CHAPTER PRESIDENT

PROFESSIONAL DEVELOPMENT OPPORTUNITIES FOR STUDENTS

With the school year back in full swing for most student members in the Society For Biomaterials (SFB), research projects and coursework have again started to dominate students' lives. For the privileged few who have earned the right to worry about meeting graduation deadlines this semester, the focus may be slightly different than the majority. While these lucky few are now in the exciting, yet stressful, process of looking for their next job, most other students will instead add professional development activities to their to-do lists this semester, along with research and coursework. Professional development opportunities are interesting in that they are often overlooked until they are actually needed. Unfortunately, when they are needed, it's often too late to get whatever valuable piece of knowledge is required. As the fall semester winds down, I'm urging student chapters to engage their membership in these professional development activities now, before they are particularly needed. Hopefully, this article can provide some examples for student chapters as the events and ideas mentioned below have already been implemented by some other chapters.

One of the easiest and most fundamental professional development activities is the coordination of a resume review session. Usually, each respective university will have a career development center or professional staff specifically dedicated to this purpose. Also included in the resume review sessions can be an introduction to curriculum vitae (CV) development. Often many graduate student members may struggle with converting their undergraduate resume to a graduate-level CV. Questions such as, "What exactly goes on a CV?" or "What do I list if I don't have publications yet?" can often be answered by these career service professionals, but it may also be helpful to pull in newly hired faculty, department chairs, or senior-level graduate students to get discipline-specific advice. The key is to develop these documents when there isn't the pressure of an impending deadline or application to complete.

Another professional development activity implemented by several of the SFB student chapters has been to visit local companies or sponsor job talks within school departments. These company visits serve two purposes. First, they give students exposure to the types of companies and positions that may be available, should they pursue a career in industry. Second, these visits allow students to network with these industry professionals. Learning to communicate research accomplishments and areas of expertise to industry professionals can be a priceless tool when the time comes to begin job searching. Often times, these companies look forward to having students visit and will assist with the logistics of organizing the trip. Unfortunately, some universities with student representation in the SFB either do not have many local companies in their proximity, or have too few student members to facilitate such a trip. In this case, do as many student chapters are learning to do, and partner with neighboring universities or other departments. Other than geography, one other hurdle in setting up these visits can be gaining access to the correct point of contact. Rely on your department faculty and recent alumni graduates to connect you to these companies themselves or to connect you to the correct person. Additionally, these visits not only foster professional development, but also may inform research projects or add context to course work.

The last suggested form of professional development is the participation in a series of mock interviews, prior to actually searching for a job. Mock interviews can be a tremendous advantage when searching for graduate schools, postdocs, industry positions, government/regulation positions, or other academic positions. These interviews give the participant a chance to have their resume evaluated by an external reviewer. But more importantly, these short interactions help the participant to grow comfortable with relaying their research/work interest to others in a concise way. Participants also grow comfortable with answering technical or personal questions that may otherwise confuse an individual during an actual interview. During last year's SFB Annual Meeting there was a scheduled mock interview session for student members. This event is usually closely associated with the annual Student Business Meeting. Please come out next year to the mock interview sessions, or better yet, set up your own at your own university!

Professional development is a continuous process and is certainly not something to be put off until graduation. Hopefully these suggestions have been helpful. Please contact me if you have any questions about getting these types of activities started or if there are any suggestions that can be disseminated to the student chapters as a whole. Thanks!

BY CARL G. SIMON JR., GOVERNMENT NEWS CONTRIBUTING EDITOR

GEORGIA RESEARCH ALLIANCE ESTABLISHING U.S. CELL MANUFACTURING CONSORTIUM

The National Institute of Standards and Technology has awarded a planning grant ($500,000, 18 months) to the Georgia Research Alliance to form a national Cell Manufacturing Consortium.[1] The goal of the consortium is to "establish a collaborative public-private partnership that engages industry, academia, regulators, and other stakeholders in removing barriers to the advancement of the cell-manufacturing industry, thereby bringing new therapies and diagnostics to the healthcare market." The current market for cell-based medical technologies, including antibodies and vaccines, tops $1 billion. The market is expected to grow several times over, due to the growing number of anticipated medical applications for cell-based technologies. However, reliable mechanisms for large scale, efficient cell manufacturing are lacking. In order to position the United States as the leader in cell-manufacturing technology, a national strategy must be developed. We must create a clear roadmap that identifies the roadblocks to success and the future research directions that can overcome these obstacles.

The goal of the consortium is to develop the roadmap and to identify mechanisms for improving U.S. cell-manufacturing capabilities in order to advance cell-based medical technologies. The consortium is being led by Todd McDevitt at Georgia Institute of Technology and will consist of nine founding partners from across the United States: Aruna Biomedical (Athens, Georgia), Celgene Cellular Therapeutics (Warren, New Jersey), Cellular Dynamics International, Inc. (Madison, Wisconsin), Georgia Institute of Technology (Atlanta, Georgia), North Carolina State University (Raleigh, North Carolina), RoosterBio (Frederick, Maryland), University of California Berkeley (Berkeley, California), University of Georgia (Athens, Georgia), and University of Wisconsin (Madison, Wisconsin).

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New Journal of Interest

Bentham Science Publishers has launched a series of innovative journals publishing review articles on recent patents in major therapeutic areas of drug discovery, as well as biotechnology, nanotechnology, engineering, computer science, and material science disciplines. One journal that may be of interest to Society For Biomaterials (SFB) members is ***Recent Patents on Regenerative Medicine (RPGM)***. It was launched in January 2011 and publishes review and research articles and guest-edited thematic issues written by experts on recent patents and related research in the field of regenerative medicine; e.g., stem cells, gene therapy, tissue engineering, and tissue and organ regeneration. Visit Bentham Science Publishers at **benthamsciencepublisher.org** and search for "Recent Patents on Regenerative Medicine" for more information.

BY STEVE LIN, INDUSTRIAL NEWS CONTRIBUTING EDITOR

Society For Biomaterials (SFB) member Dr. Ankit Agarwal, PhD, and CEO **Imbed Biosciences** Inc., reports that Imbed Bio was recently awarded a $1.5 million Small Business Innovation Research (SBIR) grant from National Institutes of Health (NIH)They also recently closed a seed equity investment round of $680,000. This will support their ongoing investment to develop unique polymeric nanofilm dressings containing silver nanoparticles. The dressing would allow closure of hard-to-heal burns and chronic wounds without infection or silver toxicity. Imbed Biosciences Inc. is a privately held medical device company located in Madison, Wisconsin. The company has patent-pending technologies on polymeric nanofilms and microfilms for delivering tailored loadings bioactive molecules on tissue surfaces. The company's vision is to develop next-generation surgical devices that can reduce patient pain and overall treatment costs, including antimicrobial dressings for dermal wounds, hernia surgical meshes, barrier films for gastro-intestinal defects, and dural membranes.

FDA has approved in 62 days a first-of-its-kind kidney disease test made by **Euroimmun**. The de novo petition was approved to allow marketing of the Anti-PLA2R IFA blood test, which determines if kidney disease is due to the body's rejection of its own kidney tissue or another cause, such as an infection. Approval was based on FDA's review of a clinical study involving 560 blood samples. The test was able to detect primary membranous glomerulonephritis (pMGN) in 77 percent of the presumed pMGN samples, and gave a false positive result in less than 1 percent of the other disease samples.

While 3D printing has been lauded as a game-changing development in the medical devices industry, the technology is battling to convince surgeons that it is a financially viable treatment for craniomaxillofacial (CMF) reconstruction, says an analyst with **GlobalData** (globaldata.com). The lack of insurance coverage for patient-specific implants and insufficient reimbursement for complex trauma cases are deterring many CMF surgeons from participating in medical training for using presurgical planning and 3D-printed implants. These concerns follow the recent FDA approval of OsteoFab Patient-Specific Facial Device (OPSFD), manufactured by **Oxford Performance Materials,** which is the only FDA-cleared, 3D-printed polymeric implant for both cranial and facial indications. While 3D-printed implants may theoretically reduce the overall cost of facial implant ownership by reducing the operating time, hospital stay duration, and chance of procedure complications, there is a lack of clinical evidence suggesting the actual cost-effectiveness of 3D-printed implants in CMF surgeries. Despite this, GlobalData expects that OPSFD's approval will lead to a further rise in the utilization rate of custom-made devices for mid-face reconstruction, mandible reconstruction, orthognathic surgeries, and possibly expanded indications.

Royal Philips and **RealView Imaging Ltd.** an Israeli start-up company, announced that they have completed a clinical study that has demonstrated the feasibility of using an innovative live 3D holographic visualization and interaction technology to guide minimally invasive structural heart disease procedures. In the pilot study that involved eight patients and was conducted in collaboration with the Schneider Children's Medical Center in Petach Tikva, Israel, RealView's innovative visualization technology was used to display interactive, real-time 3D holographic images acquired by Philips' interventional x-ray and cardiac ultrasound systems. In addition to viewing the patient's heart on a 2D screen, doctors in the interventional team were able to view detailed dynamic 3D holographic images of the heart "floating in free space" during a minimally invasive structural heart disease procedure, without using special eyewear. The doctors were also able to manipulate the projected 3D heart structures by literally touching the holographic volumes in front of them. The study demonstrated the potential of the technology to enhance the context and guidance of structural heart repairs.

St. Jude Medical announced that it was buying chronic pain treatment company **NeuroTherm** for about $200 million in cash. The Wilmington, Mass. company treats chronic spinal pain using radiofrequency (RF) ablation. It makes RF generators, RF electrodes, needles, and the disposable Simplicity probe. While St. Jude treats chronic pain using spinal cord stimulation, it doesn't play in the RF ablation market, a St. Jude Medical news release stated. The transaction was expected to close in the third quarter of the year and the acquisition will add $10-15 million to the Minnesota device maker's top line. The combination will make St. Jude Medical the only device maker to offer both RF ablation and spinal cord stimulation to manage chronic pain. Chronic pain affects more Americans than heart disease, cancer, and diabetes combined. Back in 2011, the Institute of Medicine issued a report stating that chronic pain affects 116 million Americans and costs $635 billion annually.

The mobile health devices market is set to grow to $41.8 billion in 2023, according to a new report from

Lux Research. That is an eight-fold increase from what the mobile health devices market was worth in 2013, at $5.1 billion. The growth is being fueled by demand for vital signs monitoring devices and in vitro diagnostic devices, the report found. Combined, these two will make up 75 percent of the mobile health device market by 2023. That amounts to $32.9 billion by 2023. Interestingly, after a slow start, clinical mobile health devices will zoom past their consumer counterparts; for instance, clinical vital signs monitoring devices will grow from $372 million in 2013 to $16 billion in 2023, a compound annual growth rate (CAGR) of 46 percent, while consumer applications will grow from $2.5 billion to $7 billion, an 11 percent CAGR in the same period.

The medtech jobs picture looked rosy in 2013, with the top 15 device makers in hiring mode, according to a recent **EP Vantage** report. Excluding pharmaceutical spinoffs, these companies expanded their collective workforce by 6 percent, the report says. **Baxter International** led the pack, partly by adding 10,000 employees, for a growth rate of 20 percent, from its $4 billion acquisition of **Gambro. Stryker** and **Intuitive Surgical** came in second and third, adding nearly 3,000 and 430 employees, respectively, in 2013. That's despite dismal sales and a precipitous drop in share price for intuitive. Only three of the leading companies, **Abbott, Covidien** and **Boston Scientific,** had fewer employees in 2013, the EP report said. The overall increase belies the spate of layoffs that plagued the industry in 2013. **Medtronic, Boston Scientific, Abbott Laboratories,** and **Smith & Nephew** slashed jobs last year. The job cuts continued this year, with layoffs by **St. Jude Medical, Abbott, Allergan,** and **Johnson & Johnson.**

Life sciences conglomerate **Danaher** has announced plans to acquire dental firm **Nobel Biocare Holding** for $2.1 billion in cash. The deal, assuming it passes regulatory muster, could close by the end of this year or early 2015. The acquisition of Nobel Biocare, the second biggest dental implant firm globally after **Straumann Holding,** would also likely make Danaher the market leader in dental implants. With the acquisition, Danaher expects its dental business to bring in close to $3 billion in annual sales. Last year, Danaher had revenues of $19.1 billion, while Biocare had 2013 annual revenues of roughly $750 million.

Historically, the United States has been at the forefront of innovation in the life sciences. Yet, there appears to be evidence that the dominance the country has held for decades may be fading. Upstarts in emerging regions like Asia are catching up, making the United States somewhat of an old guard. Data and charts from the Life Sciences Cluster Report published in June by **Jones Lang LaSalle,** a commercial real estate firm, capture this shift. The analysis is based on the number of Patent Cooperation Treaty (PCT) applications filed through the World Intellectual Property Organization. In 2013, there were more than 148 participating member nations in the PCT, the report said. While PCT applications from Europe have held relatively steady over the decades, North American applications are falling, while those from Asia are slowly increasing.

A recent study out of **Stanford** has provided early evidence that **Google Glass** markedly improves the surgeon's abilities. In particular, it boosts their situational awareness and ability to track vital signs in real time, thus improves patient safety as well — especially when anesthesiologists are not present. In the randomized study, 14 surgery residents performed standardized thoracostomy tube placement and bronchoscopy procedures. The group that used Google Glass to live stream vital signs could recognize a critical desaturation event during bronchoscopy 8.8 seconds earlier than the control group. The Google Glass group also could identify hypotension during thoracostomy tube placement 10.5 seconds earlier than the control group. When surveyed, the majority of participants "'agreed' or 'strongly agreed' that Google Glass increased their situational awareness (64 percent), was helpful in monitoring vital signs (86 percent), was easy to use (93 percent), and has potential to improve patient safety (85 percent)."

The FDA's powers to reclassify devices were restricted by a federal appeals court ruling that said the agency does not have the inherent authority to reclassify devices. Rather, the FDA must follow Congress's procedural requirements when reclassifying devices, including notice and comment procedures. The D.C. Circuit's U.S. Court of Appeals vacated the FDA's reclassification of **ReGen Biologics'** Collagen Scaffold (a resorbable mesh implanted inside the knee joint in treatment of injuries of the meniscus) from Class II to Class III on Sept. 26, 2014, meaning it would require a PMA instead of a 510(k). It overruled a 2013 decision in favor of the FDA from the U.S. District Court for the District of Columbia. The FDA argued that it has the authority to change its mind about the "substantial equivalence" of devices. In this case, the agency's new determination that the Collagen Scaffold lacks a substantially equivalent predecessor meant it was automatically put into Class III. The court didn't buy the FDA's argument, however, saying that "as a practical matter, the decision to revoke a substantial equivalence determination in circumstances like those present here is a de facto reclassification of the device into Class III, at least absent other FDA action."

BY YUSEF KHAN, EDUCATION NEWS CONTRIBUTING EDITOR

STEM EDUCATION AND THE NUMBERS BEHIND THE HYPE

It is difficult to pick up a newspaper or turn on the television or radio these days without hearing something about STEM and STEM education. For those who aren't familiar with it, the acronym STEM stands for Science, Technology, Engineering, and Mathematics education and defines four topics that have been identified as increasingly critical but often neglected educational components of the traditional curriculum from K-12 and beyond. As the world becomes more technologically advanced and more dependent on these advances, the United States has been evaluating its preparedness for the future and for some time has feared that the number of U.S. students pursuing STEM-based educational programs at the post-high school level has fallen behind the pace of technological advancement. A look at the projections for job needs in STEM fields and current interests and capabilities of U.S. students substantiates this concern.

It is estimated that only 16 percent of high school students intend to pursue a STEM field in higher education, and in a survey of math literacy worldwide, the United States was ranked 26 out of 35 countries.[1] Meanwhile, by 2018 there will be a need for almost 9 million STEM-trained people to accommodate the workforce needs. Fields like math and computer science are expected to expand 16-32 percent from 2010 to 2020, and fields like biomedical engineering as much as 62 percent over the same time frame.[2] As a result, the United States has been evaluating how STEM is taught in our schools, who pursues STEM-related fields, and how successful they are, and has been initiating campaigns to address the deficiencies that have been identified. In 2009, the Obama Administration announced the Educate to Innovate initiative and proposed adding 100,000 new STEM teachers over the following 10 years; increasing participation of underrepresented groups in STEM fields; enhancing STEM education in K-12 and higher education forums; and bringing the private sector into the equation of improving STEM education.[3] The Obama administration has allocated over $3 billion in 2014 for STEM education programs to support some of the Educate to Innovate initiatives, so there is substantial backing from the government toward this goal.

While advancing STEM in the United States requires input from the entire educational spectrum, we in the post-secondary academic realm may be more immediately curious about how higher education is impacted. The National Science Foundation (NSF) has compiled extensive statistics regarding student enrollment in science and engineering (S&E) fields.[1] For the purposes of these statistics, S&E fields include biological/agricultural sciences, chemistry, physics, astronomy, earth/ocean/atmospheric sciences, computer sciences, mathematics/statistics, engineering, psychology, and social sciences. NSF has gathered data from the mid-1990s through 2010 on a broad range of topics, including 1). who chooses to pursue S&E related degrees; 2). who completes the degrees; and 3). how these S&E pursuit and retention levels vary by topic, gender, and ethnicity.

Following is a broad summary of some of this data and how it substantiates the perceived need for a greater emphasis on STEM education. For full details and data spanning pre-kindergarten care through post-baccalaureate education, see **nsf.gov/nsb/sei/edTool/index.html.**

In 2010 an average of 38 percent of all incoming freshmen intended to major in an S&E field. This number has been slowly increasing from 1995 to 2010 for both males and females, but in 2010 the percentage of males was considerably higher than females (44 percent vs. 33 percent), especially considering there were 20 percent more females enrolled that same year. Interestingly, rates between ethnic groups are largely similar with Caucasians, Hispanics, and African-Americans all around 40 percent, but Asian/Pacific Islanders closer to 50 percent.

While 38 percent of freshmen enter college with the intention of completing an S&E degree, only 31 percent of all bachelor's degrees conferred are in S&E. Of that 38 percent intending to complete an S&E degree, two-thirds accomplish that goal. So while the majority of students entering STEM fields as freshmen complete those degrees, an overall minority of undergraduate students choose to pursue a STEM field of study. Within the S&E fields pursued by undergraduates, engineering had the highest retention rate with 72 percent of engineering students remaining as such throughout their degree, and computer science had the lowest, with only 62 percent. In general, students pursuing S&E fields stay within their chosen field. It seems a similar number of students drop the S&E degree altogether as stay within the broad area but switch to a different field within S&E.

Of those S&E bachelor's degrees granted from 2000 to 2010, consistently 50 percent have gone to women. Over the same time span the number of master's and doctorate degrees granted to women has slowly risen from 43 percent to 45 percent and 39 percent to 47 percent, respectively. Considering that 20 percent more women attend college than men, these numbers, while moving in the right direction, are still lower than an equal representation. Independent of gender, 64 percent of S&E undergraduate degrees have gone

to Caucasians and 28 percent to Asian/Pacific Islanders, African Americans, and Hispanics (10 percent, 9 percent, and 9 percent, respectively) and the trends largely hold up for master's and doctorate recipients. These numbers indicate an underrepresentation of African Americans and Hispanics based on their representative numbers in the U.S. population.

It would appear that concerns are substantiated by the data. What, if anything, is our role as researchers and educators? Generally, when we come in contact with students, they've already made the choice to pursue STEM-related fields, but what about retention? What can we do to keep STEM students in the programs they've begun? We seek to identify the top students and encourage them to advance, but perhaps we should also consider those that may require additional encouragement. Programs such as NSF-funded REU, RET, and REM (Research Experience for Undergraduates, Teachers, and Mentoring) grants (to name a few) are excellent tools for such endeavors and many of us already take advantage of these opportunities.

As a final thought, it is important to consider why we need to identify these underrepresented populations and focus on them. While we are all encouraged and emboldened to increase the opportunities available to those who are underrepresented in our field, we tend to think of it as our duty to provide equal opportunities for everyone. While this is certainly true, I would offer an additional consideration. It is also in our best interest, as scientists and engineers, to discover those students with hidden or untapped aptitude. We need these students. We need their gifts, their motivation, and their unbridled enthusiasm to move our fields forward. Our success as scientists and engineers depends on identifying all talent, both evident and hidden.

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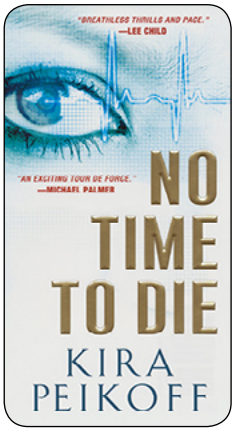
EDUCATION QUOTE OF THE QUARTER:

"Education is learning what you didn't even know you didn't know."

—Daniel J. Boorstin

Book Review

CONTRIBUTED BY LIISA KUHN, PHD, BIOMATERIALS FORUM EXECUTIVE EDITOR, ASSOCIATE PROFESSOR, UNIVERSITY OF CONNECTICUT HEALTH CENTER



Lynne Jones, book reviewer for the Biomaterials Forum, wrote an interesting review about a couple of bioethics books a few issues back. That review motivated me to include a new module in my Biomaterials class and to be interested in this novel. I picked up this book on a cross-country flight and couldn't put it down, so I thought I'd share it with you. It's a mix of science fiction and real-life scientific research that resonated with me and made me think about aging research and the possibility and implications of top-secret scientific research being conducted somewhere in the world even today. Hopefully you'll enjoy it too!

No Time to Die

By Kira Peikoff
Pinnacle Books; release date September 2, 2014
$9.99; 440 pages, ISBN: 978-0-7860-3489-5

Someone is out for blood — Zoe Kincaid's blood. She's a 20-year-old trapped in the body of a 14-year-old girl and her DNA could hold the secret of immortality. Could it be the Columbia University researchers who see her as the key to fame and tenure? The shadowy figure, known only as Galileo, who is kidnapping the world's best researchers? The Justice Department head who seems a little too intent on getting her alone? Or the maniac who just fed a leading scientist to his chimpanzees?

Zoe knows that unlocking the secrets of genomes could save her beloved grandfather, a retired physician and former Olympian who grows frailer by the day. Can she trust the rogue physician whose secret lair hides discoveries that might just save her grandfather? Heart-pounding twists just keep coming in Kira Peikoff's stunning biomedical thriller, "No Time to Die."

Science has barely begun to unlock the secrets written in our DNA. Researchers are relentlessly hunting for the answers to chronic diseases, cancer, rare disorders, and the biggest mystery of them all — aging — but at what cost? Bioethicist Peikoff asks the most troubling scientific question of our time in this taut thriller: When does medicine cross the line?

Kira Peikoff is a journalism graduate of New York University who has written for The New York Times, Slate.com, Cosmpolitan.com, Psychology Today, The Daily News, The Orange County Register, Newsday, and New York magazine on a wide range of subjects. She published her first book, "Living Proof", in 2012 and has worked in the editorial departments of New York publishing houses. She is currently at work on her third thriller, freelancing for major media outlets and attending Columbia University's Master of Science program in Bioethics.

"An intelligent, exciting tour d' force; the story is tight, the characters are fascinating, and the twists are terrific and totally unexpected... A crackling good read... Has the magic touch."

– New York Times bestselling author **Michael Palmer**

"No Time to Die *takes a terrific, original premise what if someone literally could not age? and turns it into a heart-pounding thriller that keeps its surprises coming to the last page. Fans of Michael Crichton will love this."*

–New York Times bestselling author **Joseph Finder**

"Peikoff spins a fast-paced thriller with sound cutting-edge science to explore the fundamental mysteries of aging — mysteries that, for the first time in history, we are now close to unraveling. No Time to Die *may be fictional, but it vividly evokes the most exciting aspect of my research to date."*

– *Clinical Interventions in Aging* Editor-in-Chief **Dr. Richard Walker**,

Excerpted Author Interview Questions with Kira Peikoff,
provided by Tracy G. Minsky, Meryl L. Moss Media Relations, Inc.

Q. No Time to Die *focuses on a 20-year-old woman who stopped aging at age 14. Where did you get this idea?*

A. A few years back, I saw a documentary on Discovery Health about a young woman who had inexplicably stopped aging. She was almost 20 years old but had stayed frozen as a toddler her whole life, baffling doctors and scientists alike. The case caught my attention because I've always been interested in medical mysteries, and like many people, I'm also fixated on the promise of eternal youth. Yet, staying young forever, as welcome as it might be, could also be a curse. I decided to explore it further in a novel, but I didn't want my protagonist stuck as a toddler without much mental or emotional capacity. So I decided to trap her in the worst possible age for maximum drama and frustration. What could be worse than 14?

Q. *What is Syndrome X?*
A. Syndrome X is the name researchers have given to this phenomenon of total stunted development. To date, at least six people have been identified.

Q. *Do you think scientists will find a cure for aging?*
A. Some leading researchers believe the end of aging is within reach, perhaps in the next century. One respected scientist, Aubrey de Gray, thinks that the first person who will live to age 1,000 is already alive now.

Q. *What are some of the benefits of not aging?*
A. On an individual level, endless time: Time to spend with family and friends, time to pursue infinite knowledge, passions, careers, hobbies, etc. No longer having to worry about outliving your parents or grandparents. Knowing generations of your own descendants. Living in the prime of life without breaking down physically after 70 or so years. On a societal level, much less spending on healthcare, since the diseases of aging (cancer, diabetes, and Alzheimer's) would be greatly reduced. A more robust economy, thanks to workers who retain full strength and energy long past retirement age.

Q. *What would be some of the negative results of not aging and becoming almost immortal?*
A. Individually, people might suffer from a kind of idle purposelessness if they are living so long that there's no point in "seizing the day" or making the most of life. They might start taking their time for granted and losing their ambition. But of course, you'd still have to support yourself with food, shelter, etc. And you could still get hit by a bus and die, or get sick. It's very different from actual immortality. Societally, we would have to deal with how to avoid overpopulation. People would have to have fewer children, or maybe skip generations before having children. We'd have to figure out how to make existing resources and infrastructure support the growing population. Social Security would end. I don't know if people would retire anymore.

Q. *You're studying Bioethics at Columbia University, how did you choose bioethics?*
A. I've long been interested in the intersection of cutting-edge biology, politics, and philosophy. Specifically, in the ways that exciting new advancements stand to improve human health, but are also raising unprecedented moral dilemmas. Our very definitions of life and death are being challenged by the latest innovations. It's a thrilling field to study because it's constantly evolving, and no one has all the answers yet.

Q. *Your book explores a secret network of scientists. Why is it important to regulate what happens in science labs?*
A. This is a controversial issue. On one side, you have people asserting that government regulation is necessary to protect vulnerable human subjects from exploitation by unethical researchers, which sadly happened a great deal in the early 19th and 20th centuries, before notions of patient autonomy and informed consent were popularized. On the other side, you have researchers who now feel stifled by the layers of bureaucracy, like IRBs (institutional review boards), ethics committees, and the FDA, that they need to bypass to carry out their studies. Many people, including me, are concerned that these protections have been taken too far and actually hurt more than they help, by holding back and even disincentivizing innovations that could save lives. In my book, the best and brightest researchers have become so frustrated with the slowness and inefficiency of the system that they form their own secret community to speed up progress. I think it's possible for a group of researchers to self-regulate and still treat human subjects 100 percent ethically.

Q. *In "No Time to Die", there are female scientists. Outside of thrillers, you write about science and medicine for several major publications. What advice would you share with other women interested in going into STEM fields?*
A. Study hard and be as ambitious as you can. Don't get caught up in the gender trap of thinking that science and math are for guys, and women should focus on more traditionally "female" careers. Not true! Women have just as much to offer as men. That's partly why I chose to make my heroine scientist a woman; to better offset today's male-dominated culture in technical fields.

Q. *Many young writers struggle with turning ideas into full-blown books. Do you have any advice for emerging writers trying to turn out their first book?*
A. Be patient and keep writing a little bit every day. Set a goal of your minimum word count and don't leave the desk until you hit it. I aim for 800-1,000 words a day. Outlining is very helpful so you know where you're headed and can write with purpose. If you get stuck, join a writing workshop and/or hire a writing coach or freelance editor. I have done all of the above.

To learn more about the author, visit **kirapeikoff.com.**

Coming Up in 2015

EVENT	DETAILS	WHEN & WHERE
5th International Congress Biotechnologist for Spinal Surgery	Since launching BioSpine in 2002, the focus on high-end development of many new nano- and biotechnology products within the scope of spinal surgery has been extraordinary. Join in for fruitful conversations, vigorous discussions and the mutual exchange of knowledge.	April 8-11 Berlin, Germany Langenbeck-Virchow-House
SFB Annual Meeting	The theme for the 2015 Annual Meeting is *Driving Biomaterial Innovation and the Race to Translation*, a nod to the NASCAR-driving rebels that will host this year's annual meeting. It will focus on clinical translation of biomaterial research with major topics including Biocompatibility and Immune Engineering, Biofabrication and Multifunctional Design	April 15-18 Charlotte, North Carolina 601 South College Street
31st Annual Southern Biomedical Engineering Conference (SBEC)	The SBEC emphasizes participation from young professionals and advanced students. Investigators present papers in the same sessions with the students and an author or co-author with a paper accepted will attend the conference to present their work and to interact with other attendees.	April 30-May 3 Kenner, Louisana Crowne Plaza New Orleans Airport 2829 Williams Boulevard
5th International Symposium Interface Biology of Implants (IBI)	The Symposium will include topics of generation of regenerative materials, extracellular matrix interaction, material induced biological responses, and mechanical control of cells.	May 6-8 Rostock, Germany Kurhaus Warnemünde
2nd International Conference on Regenerative Biomedical Materials	The conference aims to bring together international researchers, to explore potential collaborations in a global environment and address new theories, new experimental findings and clinical translation on topics broadly related to regenerative biomedical materials.	June 4-8 Wuhan Wuhan, China Life Science Building, HUST 1037 Luoyo Road
Stem Cells: From Basic Research to BioProcessing	This event will highlight and discuss recent advances in strategies for controlling stem cell fate and reprogramming (including new insights into the molecular basis of pluripotency and differentiation) together with the progress towards therapeutic and bioprocessing.	June 9-11 London, United Kingdom Cineworld: The O2 Peninsula Square
ASAIO 61st Annual Conference	ASAIO's (formerly known as the American Society for Artificial Internal Organs) mission is to provide a forum that globally and collaboratively promotes the development of innovative medical device technology at the crossroads of science, engineering, and medicine.	June 24-27 Chicago, Illinois 720 South Michigan Avenue
Advances in Tissue Engineering Short Course	This course will survey the latest knowledge and technologies in the world of patient-specific therapeutics — from transplantation of cells and tissues to artificial organs.	Aug. 12-15 Houston, Texas Rice University BioScience Research Collaborative 6100 Main Street
BioInterface Conference	The Surfaces in Biomaterials Foundation is dedicated to exploring creative solutions to technical challenges at the BioInterface by fostering education and multidisciplinary cooperation among industrial, academic, clinical, and regulatory communities.	Sept. 21-23 Scottsdale, Arizona 7575 East Princess Drive
6th International Conference on the Mechanics of Biomaterials and Tissues	ICMOBT provides a unique international forum for researchers and practicing engineers from different disciplines to interact and exchange their latest results.	Dec. 6-10 Waikoloa Village, Hawaii Marriott Waikoloa 69-275 Waikoloa Beach Drive
The Science of Pain and its Management	This international event will discuss the latest research relating to the physiology, psychology, and pharmacology of pain; the psychosocial aspects of pain; and the assessment and management of pain.	Dec. 8 London, United Kingdom Cineworld: The O2

SOCIETY FOR BIOMATERIALS

Charlotte, NC April 15-18, 2015

2015 ANNUAL MEETING & EXPOSITION

Driving Biomaterial Innovation and
THE RACE TO TRANSLATION

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