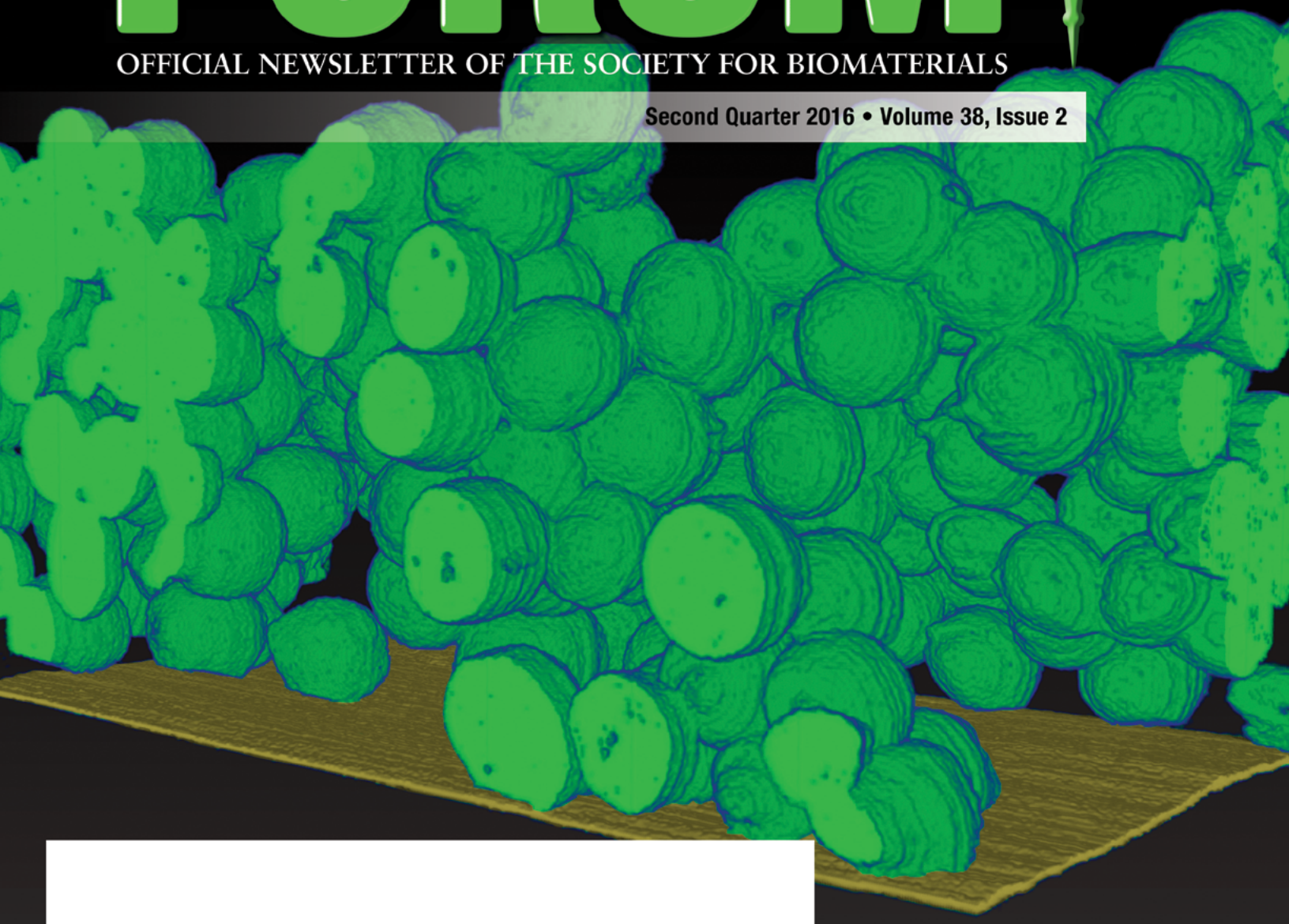
ALSO BE SURE TO CHECK OUT THE YOUTUBE VIDEO, "A LIFE-SAVING DISCOVERY AT MIT MECHE," A REMARKABLE TRIBUTE TO THE "ARTIFICIAL SKIN," DRS. BURKE AND YANNAS, AND THE FIELDS OF BIOMATERIALS AND TISSUE ENGINEERING.

BIOMATERIALS FORUM

OFFICIAL NEWSLETTER OF THE SOCIETY FOR BIOMATERIALS

Second Quarter 2016 • Volume 38, Issue 2



ALSO INSIDE

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

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

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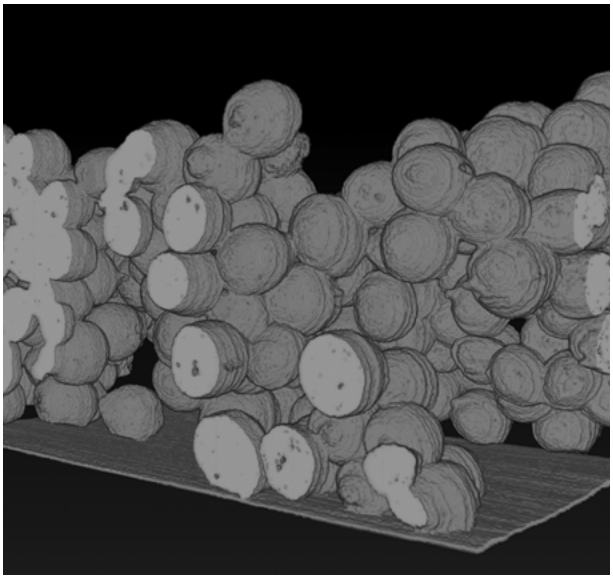
Requests for advertising information should be directed to Sarah Black at sblack@ahint.com or 856-380-6905. Information is also available on the Society's website, biomaterials.org.

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

BIOMATERIALS FORUM

The official news magazine of the **SOCIETY FOR BIOMATERIALS** • Volume 38, Issue 2

Special Interest Group Reporters



Contents

The Torch

News & Updates

On the cover: The cover image, provided by the research group of Mathew Libera at the Stevens Institute of Technology, sheds some interesting light on early-stages biofilm development in response to modulated cell-interactive surface properties. The image shows a portion of a Staphylococcus aureus biofilm grown on a nanostructured gold thin film in a 3-D rendering (reconstructed from approximately 400 serial 2-D backscattered SEM images collected overnight from the biofilm/substrate interface using automated Focused-Ion-Beam tomography with a section thickness of 20 nm).

Guigen Zhang

This issue kicks off my term as the Executive Editor of the *Forum*. I am deeply humbled and honored to be entrusted with such an opportunity and responsibility to serve the SFB.

Before highlighting the content of this issue, I would like to briefly lay out my overall plan to carry the torch forward. Building upon the successes made by all previous Executive Editors, I would aim to make the *Forum* a fun newsletter to read by all members and make them feel like an active part of the society, connected and informed. I look forward to working with the President, the Board and the various reporters and contributing editors. At the same time, I would love to hear ideas from all members about how we can add value to the publication, either through new, regular columns or occasional contributions, and how to make this "old-fashioned" newsletter relevant to all of us in a world of instant and digitized communication.

I would use the *Forum* as a communication platform to encourage discussions of scientific, translational, educational, industrial, regulatory, legislative and social matters related to biomaterials; practices for better governance of the society; recruitment and retention of memberships; and telling of the non-work-related life stories of members, etc. I would reach out to the liaisons of biomaterials societies in other countries to enhance international exchanges on a more frequent basis to promote globalization.

I would also like to tell the non-work-related stories about our members' polymath talents. I got this idea from working with Buddy Ratner on his Historical Flashback piece. Through this experience, I found out that Buddy is a polymath—a great biomaterials scientist and engineer and educator, a great guitar player and a great photographer with a great taste for good wines. This makes me wonder how many polymaths there are in SFB, who they are, what they do and, most relevant, if their non-work talents enhance their work outcomes. So if you know someone (or yourself) who fits this description, please let us know.

I will continue to ask SFB's founding members and pioneers to share with us their fond memories and services to the society, and how their careers were shaped and advanced by their association with SFB in the Historical Flashback column. From what I heard in the past, many members, long-time and new alike, enjoyed reading the less-often-told stories of the SFB. In particular, from these pieces the young and newer members got the sense the *tradition of service* in the society and many are eager to make their own contributions. Aside from looking back at the "good old days," I would like to tell the stories of our young rising stars as well. If you have any historical stories or rising star stories to tell, please send them our way.

OK, enough talking for me. Here is what you can expect in this issue: You will hear from Tom Webster in the Letter from the President, read about member news from our member-at-large (Elizabeth Cosgriff-Hernandez), student news from our student representative (Evelyn Bracho-Sanchez) and staff update from Deb Dupnik at SFB headquarters. If you have news that you would like to share with other members in future issues, please send your news to them.

I would like to draw your attention to a YouTube video, "A Life-Saving Discovery at MIT MechE," by MIT Mechanical Engineering, showcasing how a failed experiment became a life-saving discovery by MIT Professor Ioannis V. Yannas and his colleague Dr. John Burke when their search for a better way to treat severe burn victims led to the discovery of organ regeneration. "It is a wonderful tribute to the 'artificial skin' and Drs. Burke and Yannas, who were recently inducted to the Inventors Hall of Fame," says Nicholas Peppas.

In the SIG News section, the chairs from the Engineering Cells & Their Microenvironments SIG (Danny Alge), Education SIG (Anirban Sen Gupta) and Biomaterials and Medical Product Commercialization SIG (Mark Van Dyke) share with us updates and viewpoints from their respective SIGs.

In our regular columns, you will read about the latest industry news from Steve Lin and government news from Carl Simon. Moreover, you will read about some unique viewpoints on mentorship from Yusuf Khan, and on the evolution of the textbook from Lynne Jones. In the Historical Flashback column, Fred Schoen shares with us his reflection on his involvement and services to the SFB during the good and "bad" times.

One particular SFB update is about the SFB delegates' outreach in November 2015 (by Liisa Khun, Art Coury and Kai Zhang) to China and the 3rd China-U.S. Joint Forum on Innovation and Regulation of Biomaterials. This wonderful piece is filled with many memorable photos from the event.

Sincerely,

Guigen Zhang
Executive Editor, Biomaterials Forum

WORLD BIOMATERIALS CONGRESS HERE WE COME! OR AS THEY SAY IN MONTREAL, "PARIS NOUS VOILÀ!"

Thomas J. Webster

In case you missed it, the World Biomaterials Congress is next month in Montreal, and we will have an exciting showing of our U.S. research, education and everything we are doing in biomaterials. Keeping with the strong tradition of the World Biomaterials Congress, this promises to be an exciting, educational and fun-filled event for all. We will be showcasing the U.S. Society For Biomaterials (SFB) in a number of ways, including holding our traditional awards plenary session (which will be videotaped for the first time for the website this year—but please do not let that keep you from coming), business meeting and national student chapter meeting. But, our U.S. presence will be known even more this World Congress through some unique features.

For example, did you know, this year marks the 25th anniversary of our Special Interest Groups (SIGs)? As someone who "grew up" in the Society by actively participating and taking leadership roles in SIGs, I echo the statement of many that SIGs are the *true lifeline of the Society*. We will be hosting a celebration for such a monumental accomplishment occasion of 25 years of active SIG involvement at the World Biomaterials Congress!

To celebrate our global leadership, we will also be hosting events to form a Latin American SFB chapter and events to increase our strong collaborations with Asia. Did you also know that the last time the U.S. SFB hosted a World Biomaterials Congress was in 2000 (in Hawaii)? We will be making a pitch during the World Biomaterials Congress to host it once again, but this time in San Francisco in 2024 during the 50th anniversary of the U.S. SFB – what a celebration that would be! Of course, we will also welcome our next President, Liisa Kuhn, who will take over the SFB presidency as the Society continues to grow, excel, push boundaries and serve as a leader on the international stage. I am excited to welcome everyone to the World Biomaterials Congress next month in Montreal!

Please check our website (www.biomaterials.org) for all of the wonderful events we will be hosting in Montreal.

Bon voyage et à bientôt!

THOMAS J. WEBSTER, PhD, PRESIDENT OF SFB
The Arthur W. Zafiropoulo Department Chair
Professor of Chemical Engineering, Northeastern University
Boston, Massachusetts

SFB 2017 Award and Officer Nomination

LETTER OF INTENT DUE JULY 13

The Awards, Ceremonies and Nominations Committee is soliciting nominations for the 2017 awards listed below, and for the positions of President-Elect, Secretary/Treasurer-Elect and Member-at-Large for the 2017-2018 term.

2017 Awards:

- Founders Award
- C. William Hall Award
- SFB Award for Service
- Technology Innovation and Development Award
- Young Investigator Award
- Clemson Award for Basic Research
- Clemson Award for Applied Research
- Clemson Award for Contributions to the Literature
- Student Awards for Outstanding Research (PhD, Masters, Undergraduate)
- Outstanding Research by a Hospital Intern, Resident or Clinical Fellow Award

The award nomination deadline is Friday, Sept. 16; however, nominators are encouraged to submit a letter of intent to nominate to headquarters by July 13. Although a letter of intent is not required and is not binding, the information it contains will permit the Awards, Ceremonies and Nominations Committee to identify awards and positions for which apparent nominations are not forthcoming, and to solicit specific nominations as needed. Nominations will be accepted in September regardless of the receipt of a letter of intent.

To submit a letter of intent to nominate, please include your contact information, the name of the candidate, and the award or position for which the nomination will be made in an email to info@biomaterials.org.

Please contact Society For Biomaterials headquarters directly with any questions or concerns.

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Staff Update

BY DEB DUPNIK, ASSISTANT EXECUTIVE DIRECTOR

Greetings from Society For Biomaterials headquarters! Our thanks and appreciation to the vibrant city of Montreal for hosting the 2016 World Biomaterials Congress! With the beginning of a new program year, the Society's board of directors, governing council, committees, task forces and SIGs have been working hard to advance the Society's mission as described below. The following updates are from the 2015-2016 chairs.

Annual Business Meeting

The Society's Annual Business meeting took place May 20, 2016 at the World Biomaterials Congress in Montreal, Canada. Results of the spring election were announced, and the following people have been elected as officers for the SFB Board of Directors:

2015-2016 President-Elect: David H. Kohn, PhD, University of Michigan
2015-2016 Member At-Large: Andres J. Garcia, PhD, Georgia Institute of Technology
Outgoing SFB President, Tom Webster, PhD, passed the gavel to **Incoming SFB President** Liisa Kuhn, PhD.

Secretary Treasurer, Lisa Friis, reported on the Society's financial health and indicated that after three years of investment, the 2017 budget will be prepared to return net income.

Election of 2016-2017 Awards, Ceremonies and Nominations Committee: The following were elected by the members present: Christine Schmidt, PhD University of Florida; Phillip B. Messersmith, PhD, University of California, Berkeley; Stephanie J. Bryant, PhD, University of Colorado; and Todd McDevitt, PhD, University of California, San Francisco.

New Council–These members will be serving as chairs of committees, and, along with the board, will comprise the 2016-2017 Council:

Members elected or appointed to committees will be posted on the Society For Biomaterials website at www.biomaterials.org.

AWARDS, CEREMONIES AND NOMINATIONS

CHAIR: JOEL BUMGARDNER, PhD

Results of the 2016 election were announced. The following awards were presented during the awards ceremony held on May 19, 2016:

Founders Award: Cato T. Laurencin, MD, PhD, University of Connecticut Health Center
C. William Hall Award: James M. Curtis, Dow Corning Corporation
SFB Service Award: Alan Litsky, MD, ScD, The Ohio State University
Technology, Innovation and Development Award: Joseph C. Salamone, PhD, Rochal Industries
Clemson Award for Applied Research: Justin Hanes, PhD, The Johns Hopkins School of Medicine
Clemson Award for Basic Research: Molly Stevens, PhD, Imperial College of London
Clemson Award for Contributions to Literature: Rocky Tuan, PhD, University of Pittsburgh School of Medicine
SFB Young Investigator Award: Fan Yang, PhD, Stanford University School of Medicine
Outstanding Research by a Hospital Intern: Yalini Vigneswaran, MD, The University of Chicago
Student Award for Outstanding Research, Undergraduate: Abigail Loneker, University of Pittsburgh
Student Award for Outstanding Research, Undergraduate: Veronica Ibarra, Illinois Institute of Technology

Awards, Ceremonies and Nominations	Tony Mikos, PhD
Bylaws	Ben Keselowsky, PhD
Devices and Materials	Spiro Megremis, PhD
Education and Professional Development	Elizabeth Cosgriff-Hernandez, PhD
Finance	Shelly Sakiyama-Elbert, PhD
Liaison	Tim Topoleski, PhD
Long-Range Planning	David Kohn, PhD
Meetings	Liisa Kuhn, PhD
Membership	Lijie Grace Zhang, PhD
President's Advisory	Tom Webster, PhD
Program	SuPing Lyu, PhD, Rebecca Carrier, PhD
Publications	Warren Haggard, PhD
Student Chapter President	Christopher Gehrmann

Student Award for Outstanding Research, PhD: Jose Garcia, Georgia Institute of Technology
2016 C. William Hall Scholarship: Amjad Akif, The Ohio State University
2016 Cato T. Laurencin Travel Scholarships: Dwight Meggie, University of Connecticut; Julian Rose, University of Connecticut; and Roberto De Loera; University of Chicago

COMMITTEE UPDATES

AUDIT

CHAIR: TONY MIKOS, PhD

SFB received an unqualified opinion ("clean") audit report for 2015 from BBD, LLC. The financial position of the Society For Biomaterials as of Dec.31, 2015, and the changes in its net assets and its cash flows for the year were prepared in accordance with U.S. generally accepted accounting principles.

BYLAWS

CHAIR: BEN KESELOWSKY, PhD

There will be some changes proposed to the bylaws at the 2017 Annual Meeting, regarding some committees including restructuring and updating roles and responsibilities.

EDUCATION & PROFESSIONAL DEVELOPMENT

CHAIR: TIM TOPOLESKI, PhD

Since the Fall Council meeting the E&PD Committee has evaluated nominations for the C. William Hall Awards, Student Chapter travel grants, and the revised Biomaterials Day application from Northeastern University and North Carolina A&T State University. Council also approved a recent E&PD proposal to increase the interest of under-represented minorities in the field by providing a scholarship named for Cato T. Laurencin for undergraduate students to attend the 2016 World Biomaterials Congress in Montreal, Canada.

FINANCE

CHAIR: LISA FRIIS, PhD

Income and expenses are in line with projections, and the Society is in good health. Beginning in 2013, with more than $1.5 million in reserves, the Board of Directors followed the Finance Committee's recommendation to invest in membership benefits and services without increases to dues or registration. This was a conscious and strategic decision on the part of a Board, meeting their fiduciary responsibilities to the members of this non-profit organization.

LIAISON

CHAIR: DAVE PULEO, PhD

The Liaison Committee collaborated with seven other societies during this World Congress year and approved seven proposals for 2016 joint symposiums. Completed events include: Materials Research Society (MRS), Orthopaedic Research Society (ORS) / American Association of Orthopaedic Surgeons (AAOS), American Chemical Society (ACS), and Design of Medical Devices (DMD). Future events include: International Society for Stem Cell Research (ISSCR), American Ceramic Society (ACerS), New Jersey Center for Biomaterials (NJCBM) and Tissue Engineering and Regenerative Medicine International Society – Americas (TERMISAM).

LONG RANGE PLANNING

CHAIR: LIISA KUHN, 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. Priorities for 2016 included increasing public relations efforts for the society.

MEMBERSHIP

CHAIR: LIJIE GRACE ZHANG, PhD

Current membership stands at 869, with 137 new members joining since October of 2015. The total membership in April of 2015 was 958, with 280 new members joining in the four months prior to the 2015 Annual Meeting. This drop in membership is consistent with the drop we experienced during the previous World Biomaterials Congress in 2012: total membership then was 925, with just 122 new members joining in the four months prior to the Congress. There are numerous ongoing outreach efforts to attract new members and to retain existing/lapsed members.

PRESIDENT'S ADVISORY

NICK ZIATS, PhD

The committee is working to develop an ethics document to present to the Board and Council. Committee members are reviewing samples from other organizations and began working on the Preamble, a paragraph (up to four sentences) indicating what the purpose of the ethics document is to be. The ethics document will be targeted toward scientists, engineers, physicians/clinicians and industrialists.

(continued on page 11)

Please contact Society For Biomaterials headquarters directly with any questions or concerns.

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Looking Back at a Long-Term Membership

BY FREDERICK J. SCHOEN, MD, PhD

Upon completing my doctorate in materials science in 1970, I had the good fortune of beginning a job at General Atomic in San Diego, California, working on medical carbons for cardiovascular applications (literally and figuratively at the interface of materials and medicine!). My boss was Jack Bokros, a pioneer in the development of pyrolytic carbon and its innovative use in mechanical heart valves. Jack had founded several heart valve and other companies including Carbomedics and On-X, and was one of the luminaries in the early days of the Society For Biomaterials (SFB). Our collaboration with cardiovascular surgeons stimulated my interest in cardiovascular medical devices. Ultimately attending medical school and forging a career as a pathologist specializing in cardiovascular pathology, I have found the SFB to be a natural and long-standing professional home. Since I first joined in 1976, I have been involved with both enjoyment and a sense of contribution in the Society's growth and development of scientific and organizational maturity, and in the teaching and mentoring of many young scientists and engineers in the field of biomaterials. **I have taken particular pride in fostering the multidisciplinary "convergence" of the principles and tools of engineering and biological science with the realities of clinical need and corporate goals to implement medical innovation.**

Along the way, I have cultivated many long-term friendships and received valuable mentoring from some of the Society's leaders. I have been pleased to have been involved in some formative events in the field of biomaterials and in the Society's history. Several examples follow.

In 1983, I was fortunate to be a member of a delegation of biomaterials scientists on a scientific exchange to China, led by Dr. Solomon Pollack (the eighth President of the SFB), accompanied by Dr. William (Bill) Hall (SFB's first President) and involving at least five future presidents of the Society. Shortly thereafter, in 1984, at the time of the second World Biomaterials Congress, in Washington, DC, the Society was concerned about poor geographic and disciplinary diversity and static membership numbers (less than 500), conditions which restricted both SFB's influence as a professional organization and its development of new programs. As the then Chair of the Membership Committee, I developed a scheme that was supported by the SFB Executive Council: All paid non-member registrants to the 1984 meeting received a complimentary one-year membership to the Society. Since many of those provisional members became long term participants, the Society increased in size overnight, literally by approximately 50 percent (and my wife still laments the "opportunity" she had to type [on a typewriter!] the new membership list that was approved at the business meeting). Nevertheless, this well-needed rapid growth spurt stimulated an expansion in programs and opportunities that the Society continues to enjoy today.

Subsequently, I was fortunate to continue in various roles on the Executive Council and had the privilege of serving as SFB President in 1989-90. SFB's 16th Annual Meeting was scheduled for May 20-23, 1990 in Charleston, South Carolina. However, on September 22, 1989, Hurricane Hugo made landfall just north of Charleston as a Category 4 storm with estimated maximum winds of 135 mph. Hugo produced the highest storm tide heights (around 20 feet) ever recorded along the U.S. East Coast, and at the time, was the strongest and costliest storm to strike the U.S., having caused approximately $7 billion in damage. The hotel with which SFB had contracted for the meeting suffered extensive damage and could not promise that the facilities would be repaired satisfactorily to accommodate the SFB meeting. For several months, SFB leadership agonized over whether the meeting should be moved to another city or potentially postponed. In the end, after much trepidation, we pursued our original plan; the facilities were adequate and we were very fortunate to be able to hold an excellent meeting.

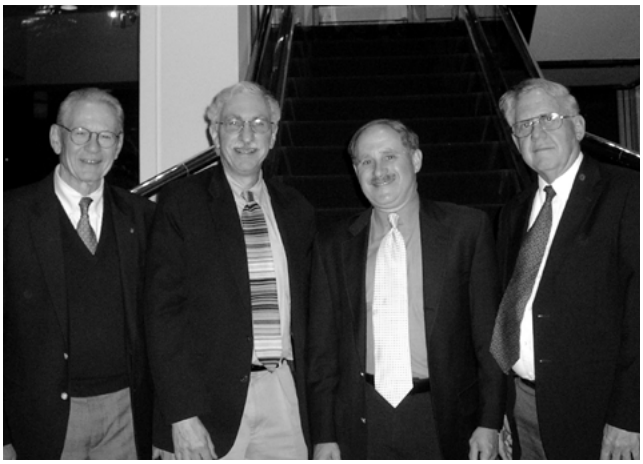
Moreover, at that meeting, the Society signed its first-ever contract for external management services. Up until that time, the SFB, as most other small professional organizations of its kind, were run by members of the leadership literally from their offices. With the growth of membership and complexity of the organization in the 1980s, SFB had exceeded the capacity of its volunteer officers. Thus, a contract was signed to provide administrative and meeting management services for the Society.

Another key milestone for the Society and the discipline was the SFB-sponsored publication of the book, *Biomaterials Science: An Introduction to Materials in Medicine*, edited by Buddy Ratner, Alan Hoffman, Jack Lemons and me. The first edition was published in 1996, the second in 2004 and the third in 2012. Many consider this book the most comprehensive reference available in the biomaterials field covering concepts of biomaterials science, relevant biology and clinical applications. With

pride, the authors have directed all royalties from the three editions of this book to the SFB, specifically designated for educational programs and student awards. Participating in the planning, writing and editing for this book has been a most rewarding and enlightening professional endeavor.

I have been pleased to serve the SFB as an active member and participant in programs and on the Program Committee, and as Chair of the Developers Committee (1996-7), the Membership Committee (1982-5) and Awards and Nominations Committee (2001-3) in addition to holding various officer positions. I have also served for many years on the editorial boards of the Society's two key journals. I have been fortunate and proud to have received the SFB's Clemson Award for Applied Biomaterials Research (1994), the Founders Award (1999) and, most recently, the Technology Innovation and Development Award (2015).

Biomaterials is an extraordinary discipline, and the SFB has shepherded and been a major driver of its growth. I have continued to have an extraordinarily rewarding career, in which biomaterials research and development, and the SFB, have played central and pivotal roles. Along the way, I have made many long-term friends through my involvement in SFB and have received extraordinarily valuable mentoring from among the Society's leaders and others.



The editors of *Biomaterials Science: An Introduction to Materials in Medicine* at the Society For Biomaterials Annual Meeting in Pittsburgh, Pennsylvania, in 2006, shortly following publication of the second edition. Left to right: Allan Hoffman, Buddy Ratner, Fred Schoen and Jack Lemons.

Members in the News

BY ELIZABETH COSGRIFF-HERNANDEZ, MEMBER-AT-LARGE

A Brief Note from the Member-at-Large
As a brief overview of my role as your 2015-2016 Member-at-Large, I serve as an unencumbered representative of the members on both the Board of Directors and the Council of the Society. In addition, I also serve as your representative on other committees (e.g., Long Range Planning Committee) so that members have a clear voice in the direction of the Society. I would like to encourage all members to send me your ideas and feedback about the Society. With your help, we can continue to improve the Society and increase value for all of our members. Another duty of the Member-at-Large is to write this column that highlights member news and accomplishments. 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. I would love to hear from you, so please take a moment to send me news for future issues.

SFB's New AIMBE Fellows
Congratulations to the SFB members elected to the 2016 Class of the American Institute for Medical and Biological Engineering College of Fellows. AIMBE's College of Fellows is made up of around 1,500 individuals who have made significant contributions to the medical and biological engineering (MBE) community in academia, industry, government and education that have transformed the world.

Eben Alsberg, Case Western Reserve University
Anthony Atala, Wake Forest Institute for Regenerative Medicine
Steven Little, University of Pittsburgh
Elizabeth Loboa, University of Missouri, Columbia
Claudia Fischbach-Teschl, Cornell University
Mariah Hahn, Rensselaer Polytechnic Institute
J. Zachary Hilt, University of Kentucky
Kristine Kieswetter, Acelity
Jan Stegemann, University of Michigan
Laura Suggs, University of Texas at Austin
Samuel Stupp, Northwestern University
Candan Tamerler, University of Kansas
Michelle Tucci, University of Mississippi Medical Center
Horst von Recum, Case Western Reserve University
Jian Yang, Pennsylvania State University

Recognitions of SFB Members
Allan S. Hoffman, Professor of the Bioengineering Department at the University of Washington, will receive the 2017 Acta Biomaterialia Gold Medal Award of the Acta Materialia at the 2017 Society For Biomaterials meeting in Minneapolis. It is given annually for excellence in research and development in the biomaterials field. There are only nine previous winners of the Acta Biomaterialia Gold Medal Award. They are, in order of receipt from the first winner: Bob Langer, Buddy Ratner, Nicholas Peppas, Michael Sefton, David Williams, James Anderson, Larry Hench, Jack Lemons and Klaas de Groot. Allan Hoffman will be the tenth winner of this award. You can find more information about this award at **actamaterialia.org/awards/acta-biomaterialia-gold-medal/**

Ariella Shikanov, Assistant Professor of Biomedical Engineering and Macromolecular Science & Engineering at the University of Michigan, was awarded the NSF CAREER Award entitled, "Dynamic transcription factor activity profiling for investigating mechanisms guiding early stage ovarian folliculogenesis." The central objective of this CAREER proposal is to discover the key signaling factors involved in the early stage development of ovarian follicles by using a systems biology approach.

Joachim Storsberg, Head of the Department of Polymers for Biomedical Engineering at the Fraunhofer Institute Applied Polymer Research (IAP), recently received the InnoPlast Solutions Award for Outstanding Contributions for Advancement of Polymer Technology for Medical Devices at the 3D Printing-Additive Manufacturing Conference in Miami, Florida, March 22-24, 2016.

Leadership and Services
Stuart L. Cooper, Professor of Chemical and Biomolecular Engineering at The Ohio State University, was elected to serve a second term, from 2016-2020, on the International Council of Fellows-Biomedical Science and Engineering Steering Committee. He also was elected to a two-year term to serve as a Director-at-Large on the AIMBE Board of Directors.

Stuart was also recently voted in as President-Elect of Sigma Xi, and will serve a one-year term as President beginning July 1, 2017. Sigma Xi, is one of the oldest and largest scientific organizations in the world, is a scientific research and international honor society of science and engineering that has maintained a distinguished history of service to science and society for more than a century. Sigma Xi, which publishes *American Scientist*, has chapters that can be found at colleges and universities, government laboratories and industry research centers around the world.

Guigen Zhang, Professor and associate chair of Bioengineering at Clemson University, SFB's new Executive Editor of the *Biomaterials Forum*, was voted in as the President-Elect of the Institute of Biological Engineering (IBE). For 21 years, the IBE, a professional society, has been supporting the community of scientists and engineers who are at the forefront of creating new linkages between biology and engineering and seeking far reaching opportunities for connecting with people and developing designs and educational perspectives through Biology-Inspired

engineering. Prof. Zhang will serve the IBE as its president in 2017 and he looks forward to exploring ways to work with SFB and other sister societies to better serve a broader community to promote the convergence of life science, physical science and engineering.

Scientific Outreach
The Design of Medical Devices Meeting hosted by the Medical Devices Center at the University of Minnesota is featuring a session on "Materials for Heart Valve Leaflets." This session was co-organized by **Peter Edelman** of Boston Scientific on behalf of the Materials and Devices Committee and is being co-sponsored by SFB. The meeting runs from April 11 to April 14, 2016.

Entrepreneurial and Translational Activities
Michael J. Moore, Associate Professor of Biomedical Engineering at Tulane University, launched a start-up company in 2014 to commercialize "nerve-on-a-chip" technology for preclinical drug testing. AxoSim (axosim.com) was recently awarded a Phase I STTR grant from the NIH to develop a model of chemotherapy-induced peripheral neuropathy.

Recent Books by SFB Members
Stuart L. Cooper, Professor of Chemical and Biomolecular Engineering at The Ohio State University, and Jianjun Guan, Associate Professor of Materials Science Engineering at The Ohio State University, published an edited collection of 22 papers on the topic of advances in polyurethane biomaterials via Woodhead Publishing, an imprint of Elsevier.

Guigen Zhang, Professor of Bioengineering at Clemson University, recently published through CRC Taylor & Francis Group an edited book entitled *Computational Bioengineering*, consisting a collection of 17 chapters highlighting the capabilities of computational bioengineering through discussions of a variety of bioengineering problems, ranging from orthopedic joint prostheses, bone remodeling, fixation devices, degeneration of load-bearing soft connective tissues and intervertebral discs, blood flow in the cardiovascular system and treatment of heart valve disease, cancer metastases and photodynamic cancer therapy, cellular and ionic activities at solid-liquid interfaces, to the operations of fluidic biosensors, among others.

Student Chapter News

BY EVELYN BRANCHO-SANCHEZ

Biomaterials Days were conceived as an opportunity for student chapters to highlight cutting-edge research in their region. This event often attracts students, academics, industry and government representatives associated with the field, but it also serves as an opportunity to inspire future generations and those curious about biomaterials. The two Biomaterials Days events this year hosted over 100 participants with extremely positive feedback from the participants.

The Biomaterials Day 2016 at University of Florida is held on March 11, 2016. This event was themed "Medical Advancement through Innovative Engineering" with the keynote address by Dr. Steven Little from the University of Pittsburgh, presenting his work on harnessing controlled-release to make medicine that imitates life. This Biomaterials Day also had an array of fabulous plenary talks given by Barbara Boyan, Virginia Commonwealth; Kevin Healy, University of California-Berkeley; Candan Tamerler, University of Kansas; and Adam Katz, University of Florida Medical. Students from the University of Florida and other regional universities also competed in both poster and oral presentations and held open dialogue with their peers about their research. The event also featured an industry information session with regional companies including Exactech, Nanotherapeutics and Axogen to help students gain perspectives on careers in industry.

From left: Dr. Kevin Healy, Luigi Ricard (UF SFB Webmaster), Dr. Adam Katz, Edward Li (UF SFB Treasurer), Laura Villada (UF SFB Advisory Board), Dr. Barbara Boyan, Dr. Steven Little, Dr. Cadan Tamerler, Cary Kuliasha (UF SFB President), Evelyn Bracho-Sanchez (UF SFB Advisory Board), Alex Collins (UF SFB Vice President), Margaret Fettis (UF SFB Secretary), Camila Edwards (UF SFB BEC Representatitve), Shanna Smith (UF SFB Historian)

continued on page 18

WBC 2016 Recap

BY LIISA KUHN, PhD, SFB PRESIDENT, 2016-2017

First, we would like to extend our deepest gratitude to Drs. Tom Webster and Nicholas Peppas for their outstanding service to the biomaterials community!

Tom Webster, PhD, Chair of the Department of Chemical Engineering at Northeastern University, completed a fantastic year in service to the Society For Biomaterials as president. He increased the Society's visibility through the development and execution of a public relations campaign that is ongoing, and he contributed greatly to our fledging webinar program by giving no less than six webinars! (There are now eight webinars in total archived on the SFB website.) SFB also expanded its Biomaterials Day Program, and conducted a programmatic outreach program sponsoring eight events at other organizations' meetings. Dr. Webster is succeeded in this position by Dr. Liisa Kuhn of the University of Connecticut Health Center. A more complete summary of the Society's progress during Dr. Webster's presidency and Dr. Kuhn's strategic initiatives for the coming year is available in the Annual Business Meeting Summary (https://www.biomaterials.org/events-2016-events/2016-annual-business-meeting-summary).

Nicholas Peppas, ScD, from the University of Texas at Austin concluded his second term as President of the International Union of Societies in Biomaterials Science and Engineering. His diplomatic skills provided cohesion to the diverse Union. After eight dedicated years of service to the global biomaterials community, we are pleased to acknowledge his contributions and are very grateful for his continued leadership of this growing field! Dr. Peppas is succeeded in this role by Professor Xingdong Zhang of the Sichuan University in China.

We'd also like to thank Dr. Eric Sussman, Chair of the Biomaterials and Medical Products Commercialization SIG. Dr. Sussman organized a site tour of the AccelLab facilities (thank you AccelLab for your support of this tour) and a very well attended panel discussion which provided insight into several regulatory case studies.

Thank you also to all the SFB Special Interest Group members who joined us to celebrate the 25th Anniversary of the SIGs formation! We were happy to see so many Americans made the trip north!

All in all, it was a very successful gathering of the world biomaterials community. Please join us in congratulating Drs. Paul Santerre, University of Toronto; Hasan Uludag, University of Alberta; Gaétan Laroche and Diego Mantovani, both from the University of Laval; and the congress secretariat Isabel Stengler, IS Event Solutions for a wonderful 2016 World Biomaterials Congress!

SFB 2017 ANNUAL MEETING

The 2017 Program Committee is requesting input from all SFB members about sessions they would like to see at the 2017 Annual Meeting. If you have any ideas, suggestions or considerations for the SFB 2017 Annual Meeting, please include the info listed for the "idea sheet" in an email and submit it to Dan Lemyre (dlemyre@biomaterials.org) for consideration by June 30, 2016. (If your idea involves a Special Interest Group, please be sure to copy the appropriate SIG Program Chair.)

This year, the Committee is interested in sessions that will explore the very latest biomaterials research in the many disciplines that participate in the SFB Annual Meeting and sessions that are pertinent to translation of discoveries to the clinic. The program committee is especially interested in ideas that center around best practices in the field for conducting cell culture studies or animal studies used to characterize the biological response to materials. By sharing our best practices with each other and with standards development organizations we can help move the field forward. Special Interest Groups are encouraged to submit ideas jointly with other SIGs or with industry in order to create the most stimulating and interesting sessions for all attendees.

A two-stage proposal process will be used to select session topics for the 2017 meeting. First, the SIGs and the Program Committee will review the submitted idea sheets. Then, those in accord with the overall programmatic objectives will be invited to submit full proposals. The Program Committee may suggest that organizers with similar ideas work together to submit a single proposal. These proposals will be due in early August. Full proposals will then be reviewed by the Program Committee and those accepted will be included in the call for abstracts. The abstract deadline will be in the beginning of November. Only after the abstracts have been reviewed can the Program Committee make the final determination that any one

particular session will be included in the final program. Sessions selection for the final program will be based on the overall quality of abstracts submitted to the session. Some sessions with fewer submissions may be combined to improve the overall quality of the meeting.

IDEA SHEET
Submit by June 30, 2016

1. Session Type (pick one):
   - » Symposium (Invited lead speaker + Abstracts)
   - » General Session (All Abstracts)
   - » Panel Discussion (All invited speakers)
   - » Poster Session
   - » Rapid Fire Session (Brief oral presentations of posters)
   - » Tutorial (Invited speakers, familiar topic)
   - » Workshop (Invited speakers, novel topic)
   - » Other (Describe)
2. Title:
3. Organizer(s) (Include name, affiliation, email and phone number)
4. Sponsoring SIG (if appropriate):
5. Theme (2-3 sentences):

Please contact Dan Lemyre at dlemyre@biomaterials.org or 856-642-4201 if you have any questions or concerns. The Program Committee is looking forward to receiving many excellent suggestions for 2017!

Thank you for your continued support of the Society For Biomaterials!

Staff Update (continued from page 5)

PROGRAM
CHAIRS: SUPING LYU, PHD AND REBECCA CARRIER, PhD
The committee is working to develop programming for the 2017 meeting with more of the session ideas being funneled through the SIGs. Since the meeting in 2017 will take place in Minnesota where there is a large medical device community, the committee plans to incorporate an industry backbone into the sessions.

PUBLICATIONS
CHAIR: ALAN LITSKY, MD, ScD
The Publications Committee reported that the Society's publisher of the *Journal of Biomedical Materials Research*, Wiley, has transitioned JBMR A and B to on-line form only. Guigen Zhang from Clemson University was approved as the new editor of the *Biomaterials Forum* and Adam Ekensair from Northeastern University was approved as Web Editor. Wiley has appointed a new "manager" for the book series – Dr. Gudrun Walter (Editorial Director Global Research, Europe, Asia, and RoW). The committee is working to develop a plan for organizing the SFB "Body of Knowledge": The Publications Committee is developing a plan to consolidate, update, and make accessible our "collective wisdom." Ideally, we'd like to develop one searchable archive where it would be possible to find any reference to a search term in any SFB-related literature – abstracts, keynotes, Biomaterials Forum, awards, videos and perhaps images, Biomaterials Bulletin, and JBMR.

NATIONAL STUDENT CHAPTERS
PRESIDENT: EVELYN BRACHO-SANCHEZ
Results of the election were announced, and the following people have been elected as officers for the National Student Chapters:
President: Christopher Gehrmann
President - Elect: Daniel Hachim
Secretary/Treasurer: Amanda Chen
Secretary/Treasurer-Elect: Rahim Jindani
Bylaws Chair: Allison Post

There are currently 19 student chapters and efforts are being made to increase this number. SFB is proud to recognize the most recent student chapter from North Carolina A&T State University, NCAT is the largest historically black university in the nation.

There are seven Biomaterials Days programs scheduled for 2016.

Updates from the Engineer Cells and Their Microenvironments (ECTM) SIG

BY DANNY ALGE

This year's World Biomaterials Congress (WBC) was a great opportunity to catch up with colleagues and hear from world-leading experts and scholars in biomaterials. It was also a good reminder to reflect on and appreciate the state of our field. I was particularly excited to see the emphasis on using biomaterials to engineer cells and their microenvironments (ECTM) in the WBC topics. When I began my career in biomaterials research, which was only about two and half World Congresses ago, the idea of engineering biomaterials to serve as cellular microenvironments was growing in importance and gaining traction, but it was not what it is today. Substrate elasticity was becoming recognized as a key variable capable of influencing the fate and function of cells. The effects of surface topography and cell shape were being elucidated. The concept of engineering synthetic "blank slate" hydrogels to recapitulate key features of the extracellular matrix and render them cell instructive was relatively nascent. I vividly recall one of the first papers I read on this topic,1 which profoundly impacted my research interests and led me on my current path. Obviously others were as excited as me about this area!

While there is still much to explore regarding how biomaterials influence and direct cells, the idea of using biomaterials to engineer cells and their microenvironment is now pervasive, and the impact it is having on biomedical research is undeniable. We have all heard about the National Cancer Moonshot initiative, and we will likely see important advances in cancer biology, drug screening and even personalized therapies as biomaterials with tunable and well-defined properties are used more frequently to engineer tumor microenvironments. However, our understanding of how to treat other pathologies will also be advanced by using biomaterials to engineer in vitro tissue and disease models. Engineering microenvironments with biomaterials is also poised to have a major impact on the clinical translation of stem cell-based tissue engineering and regenerative medicine therapies; this is an area of emphasis in my lab and the labs of several other members of the ECTM SIG. There is also significant overlap with the rapidly growing field of bioprinting, and advances in engineering biomaterial microenvironments are facilitating the design of cell-instructive "bioinks" that will help realize the potential of this revolutionary technology. We heard about all of these things at the WBC, and the ECTM SIG was well represented. Several of our members gave talks and poster presentations at the meeting on topics including neural injury and repair, cardiac tissue engineering, regulating hematopoiesis and novel methods to engineer cell-instructive materials.

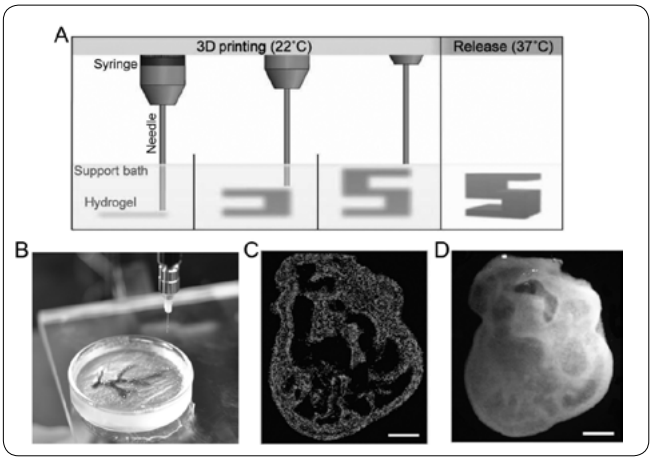


Figure 1. A FRESH Approach to Bioprinting
(A) Schematic of the approach for freeform reversible embedding of suspended hydrogels (FRESH). (B) Bioprinting of a coronary arterial tree. (C) Fluorescence image showing a cross section of a print based on an embryonic chick heart. (D) Dark-field image of the 3D printed heart with the internal structures visible through the translucent walls. Scale bars are 1 cm. (A, C and D) are adapted from Hinton et al.2 (B) is credited to Carnegie Melon University.

If you missed the WBC, there are of course other great ways to learn about the most recent happenings in our field without having to wait for the next meeting. One of my favorite platforms is actually Twitter. I follow Francis Collins (@NIHDirector), and a few months ago I saw that he tweeted about work from ECTM SIG member Adam Feinberg's lab, which incidentally is also pretty active in the Twittersphere (@RegenBio). He specifically highlighted their paper, "Three-dimensional Printing of Complex Biological Structures by Freeform Reversible Embedding of Suspended Hydrogels."2 They refer to their method as FRESH, and indeed it is a fresh take on bioprinting. In short, their method involves printing soft hydrogel materials, which do not hold their structure well, into a thick aqueous slurry of gelatin microparticles that are removed after printing and gelation. Using open-source software and hardware, they successfully printed soft biomaterials (collagen type I, fibrin, Matrigel, and alginate) into complex 3D structures, including models of a coronary arterial tree and an embryonic chick heart (Figure 1). Their technology, which they presented at the WBC, has great promise for enabling

(continued on page 18)

REFERENCES
1. Nuttelman CR, Tripodi MC, Anseth KS. Synthetic hydrogel niches that promote hMSC viability. *Matrix Biol*. 2005;24(3):208-18.
2. Hinton TJ, Jallerat Q, Palchesko RN, et al. Three-dimensional printing of complex biological structures by freeform reversible embedding of suspended hydrogels. *Science Advances*. 2015;1(9):e1500758.

For complete program information, including deadlines, please visit www.bwfund.org

Grant Programs

BIOMEDICAL SCIENCES

Career Awards for Medical Scientists: Five-year awards for physician scientists provide $700,000 to bridge advanced postdoctoral/fellowship training and the early years of faculty service. This award addresses the on-going problem of increasing the number of physician scientists and will help facilitate the transition to a career in research.

Collaborative Research Travel Grants: Provide up to $15,000 in support for interdisciplinary biomedical researchers from degree-granting institutions to travel to a laboratory to acquire a new research technique or to facilitate collaboration.

DIVERSITY IN SCIENCE

Postdoctoral Enrichment Program: Provides $50,000 over three years to support the development of underrepresented minority postdoctoral fellows in biomedical research.

INFECTIOUS DISEASES

Investigators in the Pathogenesis of Infectious Disease: Five-year awards provide $500,000 for opportunities for accomplished investigators at the assistant professor level to study infectious disease pathogenesis, with a focus on the intersection of human and microbial biology. The program is intended to shed light on the overarching issues of how human hosts handle infectious challenge.

INTERFACES IN SCIENCE

Career Awards at the Scientific Interface: Five-year awards provide $500,000 to bridge advanced postdoctoral training and the early years of faculty service. These awards are intended to foster the early career development of researchers with backgrounds in the physical/mathematical/computational/engineering sciences whose work addresses biological questions. BWF has moved to a self-nomination format for this award.

REGULATORY SCIENCE

Innovation in Regulatory Science Awards: Provides up to $500,000 over five years to academic investigators who are addressing research questions that will lead to innovation in regulatory science, with ultimate translation of those results into improving the regulatory process. These awards are intended to provide support for academic researchers developing new methodologies or innovative approaches in regulatory science that will ultimately inform the regulatory decisions the Food and Drug Administration (FDA) and others make.

REPRODUCTIVE SCIENCE

Preterm Birth Initiative: Provides $600,000 over a four-year period to bring together a diverse interdisciplinary group with the more traditional areas of parturition research to address the scientific issues related to preterm birth.

SCIENCE EDUCATION

Career Awards for Science and Mathematics Teachers: Five-year awards provide $175,000 to eligible science or mathematics teachers in the North Carolina public primary and secondary schools. The purpose of this award is to recognize teachers who have demonstrated solid knowledge of science or mathematics content and have outstanding performance records in educating children. The award is a partnership between the North Carolina State Board of Education and BWF.

Student Science Enrichment Program: Three-year awards provide up to $180,000 to North Carolina nonprofit organizations, including public/private schools, universities, colleges, and museums. This program supports creative inquiry-based science enrichment activities that occur outside the typical school day for K-12 students. The program's goals are to nurture students' enthusiasm about science, expose them to the excitement of scientific discovery, and interest them in pursuing careers in research or a variety of other careers in science.

Promoting Innovation in Science and Mathematics: Awards provide teachers with funding for materials, equipment, and training to conduct hands-on, inquiry-based science and mathematics projects in North Carolina public schools.

BURROUGHS WELLCOME FUND

The Burroughs Wellcome Fund is a private foundation located in Research Triangle Park, North Carolina. Find out more at **bwfund.org**

Incorporating Translation and Commercialization Awareness as a Core Component of Biomaterials Education

BY ANIRBAN SEN GUPTA (EDUCATION SIG) AND MARK VAN DYKE (BIOMATERIALS & MEDICAL PRODUCTS COMMERCIALIZATION SIG)

Anirban Sen Gupta

Mark Van Dyke

To enhance Biomaterials education, the Society For Biomaterials (SFB) has created an excellent platform in the form of the Biomaterials and Medical Products Commercialization (BMPC) SIG, where the translational regulatory and commercialization pathways for many biomaterials systems can be aptly discussed at the professional society level. These issues have also been discussed in several excellent opinion articles and webinars.[1-6] Here we will rationalize why some of these knowledge components should become an integral part of biomaterials education at the departmental and institutional level, so as to build translational awareness among young students as well as established academicians and kindle the entrepreneurial spirit.

First, it is important to define the meaning of "translation" in the context of biomaterials research. We often use the phrase "bench-to-bedside" loosely to imply translation, which essentially means the utilization of findings from fundamental science and engineering into realistic and meaningful ways of improving human health. In the context of biomaterials, this can be quite complex since the intended end result is direct interaction with the human body (and animals, if veterinary medicine) without eliciting adverse effects. The majority of educational activities (and research) that are conducted in the biomaterials realm essentially fall under a combination of basic research and applicative research categories, but not necessarily within a deliberate translational framework. Basic research in biomaterials can be defined as *research performed with a focus on enhancing general knowledge and understanding of materials and their properties in terms of chemistry, physics and biology to answer a large number of important practical questions*, though the research may not give a complete specific answer to any one of those questions.

Applicative research in biomaterials is focused at *leveraging the knowledge gained from basic research toward answering a specific question or achieving a specific function.* Common examples of this are research that focuses on answering questions like "can the controlled modulation of material degradation be utilized for drug delivery," "can a material's mechanical properties make it suitable for orthopedic applications," "can a material's effect on cellular phenomena be utilized to enhance or retard a certain type of cell growth or differentiation," etc.

Translational research is a further enhancement of Applicative Research, defined in essence by the NIH entities as: *a research process of applying discoveries generated during laboratory research and preclinical studies to the development of trials and studies in humans, while enhancing the adoption of best practices as well as emphasizing cost-effectiveness.* The pathway of taking a biomaterials discovery to this translational end point can be quite arduous in practice, but an awareness of this pathway early on in students and researchers can help them recognize and appreciate the discoveries, as well as, design experiments with a vision toward "real world application."

What are some of the core components of translation and commercialization that can be potentially incorporated in the fold of educational awareness in the biomaterials arena? The first is intellectual property (IP), which in many cases takes the form of a patent. As defined by Ben Ikenson[7]: *a patent protects a person's idea or invention so that they might rightly profit from it, thereby encouraging innovation as a means to prosperity.* Legally, however, a patent imparts a negative right; that is, the right to exclude others. A basic understanding that a good idea may or may not necessarily be a new (innovative) idea and therefore may or may not be patentable (even though it can be potentially easy to translate), can immensely benefit the subset of students and researchers that has an entrepreneurial spirit. A further understanding that an innovative idea may or may not be realistic or adequately cost-effective, may help refine that idea further to meet certain translational requirements.

The second is a basic educational introduction on regulatory pathways. A couple lectures that outline the role and requirements of the Food & Drug Administration (FDA) in the context of biomaterials-based systems (e.g., FDA-defined device categories, standard materials biocompatibility test requirements like ISO 10993, descriptions of FDA entities like Center for Devices and Radiological Health [CDRH], Center for Drug Evaluation and Research [CDER] and Center for Biologics Evaluation [CBER], awareness of regulatory terminologies, etc.) can be of great benefit for

<table>
<tr>
<td rowspan="2">Key Partners
6
Who (personnel, offices, clinical and industrial entities, regulatory entities, etc.) will you need to work with to go forward in translation and commercialization activities</td>
<td>Key Activities
3
What specific milestones (in vitro and in vivo milestones, regulatory milestones, clinical trials, etc.) need to be achieved to successfully translate</td>
<td rowspan="2">Value Propositions
1
- What is your technology?
- What is the Minimum Viable Product (MVP)?
- What are the unique advantages compared to existing technologies?
- What is the competitive landscape?
- If it is a completely new area of technology, what is the need for it?</td>
<td>Customer Relationships
7
What strategies will you utilize to educate potential customers about your technology and build sustainable relationships with them</td>
<td rowspan="2">Customer Segments
2
- Who will be the customers of your technology?
- What subset will be interested in the MVP?
- Who will be interested beyond MVP (expanded portfolio of technologies)?</td>
</tr>
<tr>
<td>Key Resources
4
What specific resources (materials, facilities, equipment, collaborations, advisors, etc.) are needed to achieve the Key Activities milestones</td>
<td>Channels
8
What resources and organizations will you need to work with in order to develop the customer relationships</td>
</tr>
<tr>
<td colspan="3">Costs
5
What are the potential costs involved (labor, manufacturing, in vitro studies, pre-clinical studies, clinical trials, etc.) in translation and commercialization of a technology or a product?</td>
<td colspan="2">Revenue Streams
9
What would be the revenue resources that can provide the funds to handle the costs delineated in box 5?</td>
</tr>
</table>

Figure 1. An example Business Development Canvas Adapted from NSF-I-Corps™

students to appreciate the complex regulatory attributes associated with biomaterials in the context of devices, drug delivery systems, pharmaceutical formulations, tissue engineering, regenerative medicine, etc., which are common biomaterials application topics in the courses. A fun exercise in a core biomaterials course can be students working in teams to chalk up a rudimentary business development and translation canvas for a number of well-defined (and possibly already well-established) biomaterials technologies from the hypothetical framework of "what if they were the ones who invented that technology." A great example template for such a canvas development exercise is the NSF I-CorpsTM type of canvas, as shown in Figure 1.

A third is that students should be made to appreciate is the basic economics of biomaterials and medical device development. Unlike industries with fewer government regulations, regulatory-related timeframes and expenses that dominate development costs heavily overshadow medical products. Teaching students not only the basic costs of manufacturing medical products in compliance with the prevailing laws, but also the economics of investment capital and the need for return on that investment is essential.

The Society For Biomaterials is rich in members from academia and industry who have dedicated decades of their lives in developing, translating and commercializing a wide variety of biomaterials-based technologies. A think tank comprising such members and the BMPC SIG may be able to discuss and draft an educational component guideline that can immensely help refine curricular structure of core biomaterials courses to provide a flavor and awareness of translation and commercialization, without compromising the emphasis on basic and applicative aspects of biomaterials research. The Biomaterials Education SIG remains deeply interested and committed to development of such educational components that can become an integral part of biomaterials course syllabi and textbooks.

REFERENCES

1. Washburn NR. *J Biomed Mater Res A*. 2011;96(1):58–65.
2. Hunsberger J, et al. *Stem Cells Translational Medicine.* 2015;4:130–135.
3. Rubio DM, et al. *Acad Med.* 2010;85(3):470–475.
4. Prestwich GD, et al. *Science Trans Med.* 2012;4(160). doi: 10.1126/scitranslmed.3004915.
5. Webster T. *SFB Webinar: Starting a Biomaterials Company.* Society For Biomaterials website. https://www.biomaterials.org/publications/news/webinar-starting-biomaterials-company
6. Woolf SH. The meaning of translational research and why it matters. *JAMA.* 2008;299(2):211–213.
7. Ikenson B. *Patents: Ingenious Inventions How They Work and How They Came to Be.* New York, NY: Black Dog & Leventhal Publishers Inc.; 2004.

Mentorship: What It Is and How It Can Encourage STEM Students

BY YUSUF KHAN, EDUCATION NEWS CONTRIBUTING EDITOR

As professors, postdoctoral fellows, and graduate students we all have found ourselves at one point or another in a position of mentor or mentee and it is safe to say that we have all either had an impact or been impacted by this relationship at some point. Previously we have examined science, technology, engineering, and math (STEM) education and how it relates to the field of biomaterials and much of that discussion has revolved around how to recruit and retain students within the discipline. Here we discuss mentorship; what it is, how it exists, and programs that harness it to support STEM education.

In the academic biomaterials world mentorship most likely manifests as student-professor relationships where the professor is mentor and the student is mentee. While certainly within the scope of mentorship, this does not completely define the concept. Mentorship has been defined as "a one-to-one relationship in which an expert or a senior person voluntarily gives time to teach, support, and encourage another"[1], "…who helps a protégé learn something that he or she would have learned less well, more slowly, or not at all if left alone."[2] From this we can see how the professor-student (or professor-fellow) relationship falls within this definition, regardless of whether it is voluntary, but the notion of mentorship also exists beyond this relationship often continuing long after these particular roles have changed.

Mentorship can be either formal or informal. The former, usually part of an institutional mentorship program, may initially be short-term with the potential for it to exist longer, and the mentors are typically volunteers. Research on the topic of mentorship differs in whether a formal mentor should be a supervisor[3] but in an academic setting the professor would most assuredly be considered a supervisor. This does not mean that all academic mentors need to follow this pattern. Informal mentoring is characterized by a "natural coming together of mentor and protégé"[3] often through friendship, respect, or perhaps professional aspiration. This relationship is considered more durable in the long-term than a formal mentorship and is often an important supplement to the traditional academic mentor-mentee relationship. Then there is peer mentorship, which involves an advisory relationship between peers, for example between co-workers or students. A number of peer mentorship programs are found at universities around the country in which, for example, a new undergraduate student is paired with an upperclassman, usually in a formal structure that facilitates regular meetings between the two with consistency and predictability.

The formal peer mentorship strategy matches students together based on similar age, interests, and academic studies, and allows them to connect on perspective and life experience, something that can be lost when the age and life experience gap between mentor and mentee gets too large. These relationships can be symbiotic, providing the incoming student with a source of valuable information, perspective, and emotional support while giving the mentor the opportunity to be an advisor, sometimes for the first time in their lives. Current research is inconclusive about its effectiveness on academic performance but it does seem to support its effectiveness in psychosocial measures. The same research also supports formal peer mentorship programs over informal, as the latter can be less effective due to inconsistent meetings, academic differences, and reduced participation by both parties.[4]

It seems clear that a good mentoring relationship can pay significant dividends academically, career-wise, and personally, but less clear is its role in encouraging students to pursue academics, or from our perspective pursue an academic path in STEM-related fields. We previously discussed the national need for more students to enter STEM fields of study and research has suggested that a lack of STEM mentorship in secondary schools reduces the number of students entering the field, largely because these students don't know anyone that works in a STEM related job or don't fully understand what people in STEM fields do.[5] There are, however, programs that exist to formalize STEM mentorship, like the National Science Foundation Research Experience and Mentoring (REM) program. The NSF REM program is within the Emerging Frontiers in Research and Innovation program and supports mentored research opportunities for those interested in STEM related fields. It provides funding for high school students, STEM high school teachers, undergraduate students, faculty, and veterans to join NSF-funded research laboratories around the country.

(continued on page 21)

REFRENCES

1. Santamaria JO. Mentoring develops high-potential employees. *Asia Africa Intelligence Wire.* 2003.
2. Bell CR. The mentor as partner. *Training and Development.* 2000;54(2):52.
3. Inzer LD, Crawford CB. A Review of Formal and Informal Mentoring: Processes, Problems, and Design. *Journal of Leadership Education.* 2005;4(1):31-50.
4. Bonin E. Effect of Peer Mentors on Academic Performance. *Rivier Academic Journal.* 2013;9(2):1-8.
5. The Case for the STEM Mentoring Movement. https://US2020.org. Accessed April 4, 2016.

Events Happening in the Industry

BY STEVE LIN, EXACTECH

Johnson & Johnson says that it will cut more than 2 percent of its global workforce of around 127,000 people, and 4 percent to 6 percent of its employee in medical devices, in light of a grim year in sales of prescription drugs, medical devices, and consumer medicines. According to the company, the restructuring will focus on its orthopedics, surgery, and cardiovascular businesses, and will not affect consumer medical devices, pharmaceuticals, or consumer businesses. The company expects that the restructuring will save between $800 million and $1 billion a year before taxes, and hopes to reinvest some of the savings in new product development.

Abbott Laboratories announced that it will acquire the diagnostic firm **Alere** (Waltham, Massachusetts) for $5.8 billion, a move that would bolster Abbott's point-of-care diagnostic business, projected to be approximately $7 billion annually. The acquisition would give Abbott an expanded portfolio of benchtop and rapid diagnostic strips. The diagnostic business is projected to be strong in coming years. Now valued at $60 billion internationally, the sector is growing at a rate of approximately 5 percent per year according to Goldman Sachs.

Stryker said that it will acquire Cary, Illinois–based **Sage Products**, which manufactures a host of products meant to prevent so-called "never events" in ICUs and hospitals, including hospital-acquired infections. The all-cash transaction, valued at $2.775 billion, is expected to close in the second quarter of 2016, once approved. Other recent developments by Stryker include plans to build a brand new, state-of-the-art 3-D printing manufacturing facility this year for producing new innovative products and parts including revision cones and titanium interbody spine device.

Johnson & Johnson announced its plans to purchase privately-held **NeuWave Medica**l (Madison, Wisconsin) for an undisclosed sum. NeuWave makes minimally invasive soft-tissue microwave ablation technology for surgical applications including the removal of soft tissue growth and ablation of tumors in the lungs, liver, kidneys, and bones. The company was founded by Fred Lee and Daniel van der Weide with technology licensed from the Wisconsin Alumni Research Foundation.

Apple filed a patent for a medical monitor that can sound an alert based on irregularities in a user's temperature, heart rate, oxygen level, or blood pressure. In its patent filing with the U.S. PTO, Apple states that the device can detect "care events" and sound alerts in the case of medical emergencies such as a heart attack or a fall. In addition, the device could alert family or police of events such as car crashes, bike accidents, a mugging, or the separation of a child from the child's caregiver, and could potentially store medical records or other medical information or obtain the information from other devices.

Canon plans to expand its presence in the medical device sector through acquisition of **Toshiba's** medical device business in a 665.5 billion yen ($6 billion) transaction. If the deal is completed, it would give Canon control of a growing $3.5-billion-a-year diagnostic imaging equipment business covering everything from MRI to CT, ultrasound and X-rays. Toshiba needs a cash infusion as it grapples with an accounting scandal involving nearly $2 billion in overstated profits over the past seven years. The U.S. Justice Department and SEC have made inquiries about its accounting practices.

Philips' Murrysville, Pennsylvania–based Respironics division was accused by the Department of Justice of offering free call center services to suppliers of durable equipment to sway them to buy their sleep apnea masks. The company has agreed to pay $34.8 million to resolve those charges without admitting guilt. The fine would be one of the larger fines levied on medical device companies in 2015 or 2016 but would be significantly less than the $646 million that **Olympus** stands to pay over endoscope kickbacks.

Abbott Laboratories could face a $1 billion fine in a federal whistle-blower lawsuit over off-label use of stents, and allegations of Medicare fraud and kickbacks paid to hospitals and physicians for such use. The jury trial just began in U.S. District Court for the Northern District of Texas in Dallas, 10 years after former Abbott and Guidant sales representative Kevin Colquitt brought the allegations. Abbott acquired Guidant Corp.'s vascular business in a 2006 multibillion-dollar transaction that involved **Boston Scientific** and a competing bid by **Johnson & Johnson.**

The FDA has sent a warning letter to **Terumo Corp.**, regarding its manufacturing and quality control deficiencies related to its Destination line of guiding vascular sheaths. The warning letter stemmed from an FDA inspection of the company's facilities on October 19, 2015. While the company had responded several times to the FDA, the agency concluded that the firm's response was inadequate and stated that the company had not demonstrated the effectiveness of all of the identified corrective actions outlined in earlier communications.

National Cell Manufacturing Consortium Publishes Roadmap

Government News

BY CARL G. SIMON JR.

The challenge of reproducible, cost-effective manufacturing of cells for clinical use is a major roadblock for the regenerative medicine industry. The National Cell Manufacturing Consortium (NCMC) aims to establish a roadmap for developing technologies for manufacturing high-quality cells.1 Since its founding in 2014, NCMC has convened a series of workshops involving nearly 100 experts from approximately 60 organizations representing industry, academia, clinical facilities, private foundations, and government agencies, and has just published in February 2016 the roadmap with two main foci.2 The first is to "develop and implement advanced technologies and techniques" that address i) cell processing; ii) cell preservation, distribution, and handling; and iii) process monitoring and quality control. The second is to "strengthen the industry foundation" through i) workforce development and ii) standardization and regulatory support. The roadmap will be used to guide how we invest our resources in order to effectively advance cell manufacturing.

REFERENCES

1. National Cell Manufacturing Consortium. NIST Advanced Manufacturing Office website. http://nist.gov/amo/amtech/70nanb14h048.cfm. Accessed May 6, 2016.
2. Achieving Large-Scale, Cost-Effective, Reproducible Manufacturing of High-Quality Cells: A Technology Roadmap to 2025. National Cell Manufacturing Consortium; 2016. https://cdn.shopify.com/s/files/1/0515/3253/files/CMC_Roadmap_021716_150ppi.pdf?2424417672465838090

Student Chapter News (continued from page 9)

News & Updates

University of Memphis and University of Tennessee Health Science Center, together with Vanderbilt University and the University of Kentucky, held their Biomaterials Day 2016 on March 18, 2016. The keynote speaker for this event was Dr. John Rose, Principal Scientist in Biomaterials in Advanced Surgical Devices from Smith and Nephew. Aside from research presentations in tissue engineering, fabrication methods, and simulation and modeling host responses, there were several panel discussions focused on career paths empowering women in engineering and a poster session for students to showcase their work. Additionally, the students organized a STEM education workshop to discuss ideas and best practices for STEM education at all levels from primary school to college and beyond.

Alternative careers panel at Biomaterials Day 2016 hosted at the University of Memphis. From left: Chris Przybyszewski, Kerem Kalpaksi, Karen Hasty, Allan Daisley

Updates from the Engineer Cells and Their Microenvironments (ECTM) SIG (continued from page 12)

News & Updates

organ bioprinting. Other highlights that I caught on Twitter were about Brendan Harley's lab (@Prof_Harley) starting a new R01 project on engineering biomimetic hydrogel niches to study glioblastoma multiforme malignancy, which was mentioned in the last *Biomaterials Forum* update from the ECTM SIG, and the recent Molecular, Cellular and Tissue Bioengineering Symposium that was held at Arizona State University and co-chaired by Sarah Stabenfeldt. These are just a few of the highlights that I have recently enjoyed seeing. I encourage you all to join me in using social media to look for future updates from members of the SFB community and to even share your own!

SFB TRAVELS TO CHINA FOR THE THIRD CHINA-U.S. JOINT FORUM ON INNOVATION AND REGULATION OF BIOMATERIALS

BY LIISA KUHN, ART COURY AND KAI ZHANG

The idea of holding a series of forums aimed to promote international business collaboration in the biomaterials field was conceived at the last World Biomaterials Congress held in 2012 by Professor Xingdong Zhang, president of the Chinese Society for Biomaterials (CSBM) together with several past Presidents of SFB. The first two forums were held during the 2013 SFB annual meeting in Boston and the 2014 annual SFB meeting in Denver. The success of these events led to the third joint forum recently held Nov. 19, 2015 at the Chinese Biomaterials Congress in Haikou, Hainan, China. The forum consisted of presentations given by invited speakers from regulatory agencies, leading Chinese and global companies, clinical research institutes, and academia (view the program at www.csbm.org.cn/annualmeeting2015/). The U.S. SFB sent a delegation of 22 members including 10 members of the U.S. National Academy of Engineering to attend the forum and other associated events (Jim Anderson, Kristi Anseth, Art Coury, Richard Korsmeyer, Cato Laurencin, Kam Leong, Nicholas Peppas, Len Pinchuck, Buddy Ratner, Joe Salamone, Shrojal Desai, Liisa Kuhn, Steve Lin, Helen Liu, Jon Mosely, Wei-ping Ren, Carl Simon, Timmy Topoleski, Alex Wu, Jian Yang, Guigen Zhang and Kai Zhang). With the goal of creating favorable opportunities for products and companies to enter the market of the partner country, the talks focused on standards, regulation, innovation, technology transfer, market access, and customer service. The speaker lineup was impressive and gave attendees the opportunity to speak to knowledgeable authorities from both countries together in the same room (photos 1-6). The host of CSBM made the entire event a memorable and enjoyable experience for each US SFB delegate. The forum provided truly valuable opportunities to learn about the latest medical device and regenerative medicine product successes in both countries. Most important, attendance at the forum enabled participants to set up future business meetings directly with the appropriate contacts rather than attempting to navigate a corporate structure on their own. In addition to the forum speakers, a group of nine U.S. national academy members were present and had participated in the China-U.S. Forum on Grand Challenges for Biomaterials in the 21st Century in Chengdu, Sichuan, China prior to the meeting (photos 7,8). The forum invited biomaterials experts from both China and the U.S., the largest developing and developed entities, to solicit and exchange ideas on the opportunities and challenges for biomaterials in the new century. The joint forum was on the first day of the 2015 Chinese Biomaterials Congress (photos 9,10). There were close to 1500 attendees for the Chinese Biomaterials Congress, likely the highest number of attendees for a national-level Chinese biomaterials' meeting. Many of the SFB delegates gave scientific presentations enabling the CSBM to hold their first English speaking sessions at the annual meeting. The last event was a China-U.S. Forum on Biomaterials Industrialization in which members of the U.S. National Academy of Engineering were invited on corporation tours (photo 11).

SFB President-Elect Liisa Kuhn and the newly elected CSBM President Yingjun Wang discussed their shared determination to continue the momentum of these joint forums. A planning meeting for the fourth joint forum will be held at the World Biomaterials Congress in Montreal, and the tentative site for the next joint meeting in 2017 will be in Guangzhou, China. Please contact Dan Lemyre, dlemyer@ahint.com, if you are interested in participating in the next forum.

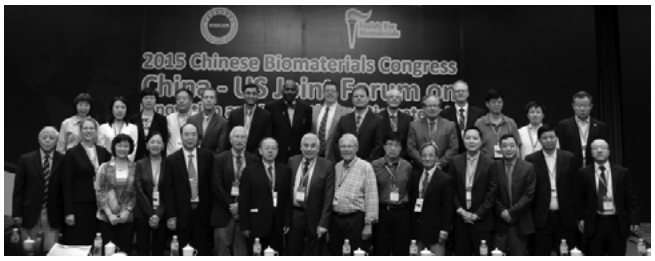


Photo 1. A group photo of the speakers of the joint forum between CSBM and SFB held Nov. 19, 2015, in Haikou, China.

Photo 2. China-U.S. Joint Forum Co-Chairs Xingdong Zhang and Art Coury

Photo 3. Approximately 400 people attended the joint forum.


Photo 4. SFB President-Elect Liisa Kuhn spoke about the role of ASTM standards in product commercialization and Past President James Anderson (shown at the Guangzhou meeting that followed the forum) discussed the role of ISO standards. SFB members have long played a critical role in developing world-wide biomaterials standards.

Photo 5. Organizing Committee Directors Shrojal Desai (left) and Kai Zhang.

Photo 6. A panel discussion with the speakers was held at the end of the forum.

Photo 7. A group photo for the China-U.S. Forum on Grand Challenges for Biomaterials in the 21st Century held prior to the joint forum (Nov. 17, 2015 Chengdu, China).



Photo 8. Participants in the Grand Challenges event held in Chengdu prior to the joint jorum in Haikou. (l to r: Nicholas Peppas, Leonard Pinchuck, Art Coury, and Cato Laurencin).

Photo 9. Opening ceremony of the 2015 Chinese Biomaterials Congress (Nov. 20, 2015 Haikou, China)

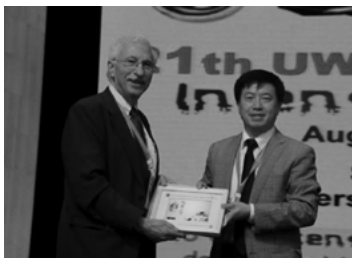


Photo 10. Invited speakers were presented with medical grade titanium commemorative plaques.

Photo 11. Group photo of the China-U.S. Forum on Biomaterials Industrialization in Guangzhou, China, Nov. 23, 2015.

The Evolution of the Textbook

Book Review

BY LYNNE C. JONES, PhD; JASKEERAT AHLUWALIA; CHRISTINE JONES, BS; AND AMY L. JONES, MS

Reading material and other reference resources have always played an integral part of the education of undergraduate and graduate students. Over the past two decades, there has been a marked increase in the availability and accessibility of electronic versions of these materials. These electronic resources are touted as a major convenience to students. The advantages are that they are never out of stock, immediately downloadable and cost effective.

There are different forms of access: 1) complete download of the textbook and 2) online access. The online access can be time-limited, similar to a book rental. The time limitation can be variable, ranging from a trial period to a two-semester course. Instructors are increasingly using electronic versions of their required textbooks. They are also able to require the latest edition of textbooks – no longer trying to accommodate students purchasing used books. They are also able to include limited editions of reading materials.

The 21st century has brought a rapid evolution of technological resources to education and research. Students and their instructors have access to the internet through a variety of hardware (smartphones, tablets, laptops, desktops and workstations); this access is pervasive in their academic and social lives. Instruction manuals for software and other electronic media are no longer readily available in printed form; it is expected that they are accessed through the Internet. Increasingly, instructors are selecting core and supplemental readings that are available electronically for their courses.

Going Digital

A major advantage of electronic textbooks and resources include the convenience. In addition to the increased accessibility described previously, tablets are easily portable, enabling students to carry all of their textbooks at one time. There is also increased functionality related to the searching ability, electronic copying, highlighting and commenting. Students can use the cut-and-paste capability to insert quotations within their papers; often the citation will accompany the quote.

The Advantages

Font and lighting adjustment enable the reader to adjust to their visual needs. Some online books also include other study materials and practice questions. Audio versions of textbooks may also be available. Compared to printed textbooks, electronic textbooks are generally cheaper. There are also advantages to the instructor. For example, the electronic versions not only allow access to the most recent versions of the textbook, but also allow the authors of the textbook to provide updates to their text in a timelier manner (than waiting for another edition). Electronic and internet availability also permit hyperlinks to definitions and additional materials, as well as Web and multimedia tie-ins. For example, a description of a technique within the textbook can be linked to YouTube videos demonstrating the technique.

The Disadvantages

While accessibility to a computer is not as much of an issue today as in the past, some students may have to use the library for computer loan/use; therefore, there could be limits to library access (e.g., library hours). The availability of some textbooks may be set to expire after a certain period of time. Unlike purchased textbooks, certain electronic textbooks may not serve as a permanent resource. Another potential limitation is that some downloads are limited to one computer. This can be an issue for when a computer fails or is stolen. There are potential limitations regarding the cost to the student. If a textbook is updated, there may be an additional cost for the updated textbook. Frequent updates also may enable more frequent upward adjustment of the cost of the textbook. Furthermore, there is no reselling of the text – often done to offset some of the cost of the original textbook.

Conclusion

We have arrived at the age of electronic textbooks and digital. The choice of print or electronic version is left to the student preference. The advantages to the student, the instructor and the publisher outweigh any potential disadvantages. And furthermore, the use of electronic textbooks is environmentally friendly. The end result will be an increase in access and use of digital media (e-textbooks, videos, etc.), providing an enhanced learning experience.

Mentorship: What It Is and How It Can Encourge STEM Students (continued from page 16)

Education News

It focuses on recruiting those from inner city schools and historically underrepresented populations in STEM fields at both community and four-year colleges. This program seeks to answer the existing national need by providing an important formal structure to the mentorship relationship described above. While not the only program that encourages STEM mentorship, the NSF REM program is prominent in its reach, and has proven valuable and productive since its inception. Have you run a REM funded program? Have you participated in one? Feel free to contact me if you have and perhaps we can highlight your experiences in a future column.

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