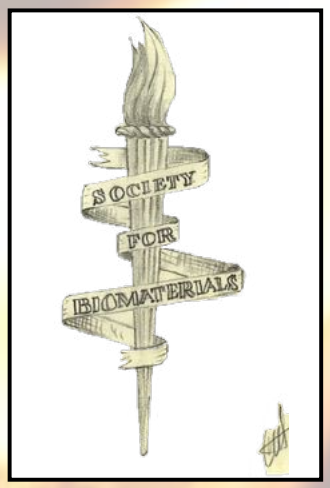
CARRYING THE TORCH

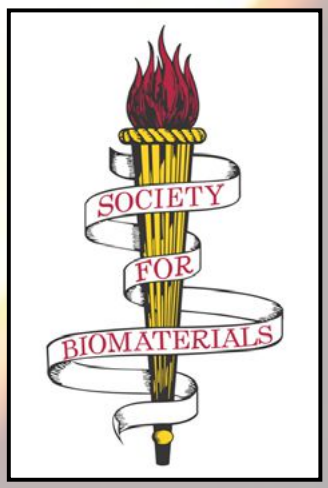
BIOMATERIALS FORUM

OFFICIAL NEWSLETTER OF THE SOCIETY FOR BIOMATERIALS

FOURTH QUARTER 2021 • VOLUME 43, ISSUE 4

A Match





Society For Biomaterials

A History of the Society For Biomaterials

ALSO INSIDE

THE ABC'S OF BIOMATERIALS EDUCATION:

THROUGH THE LOOKING BIOGLASS OF IDIOMS AND ANALOGIES

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

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BIOMATERIALS FORUM

The official news magazine of the **SOCIETY FOR BIOMATERIALS** • Volume 43, Issue 4

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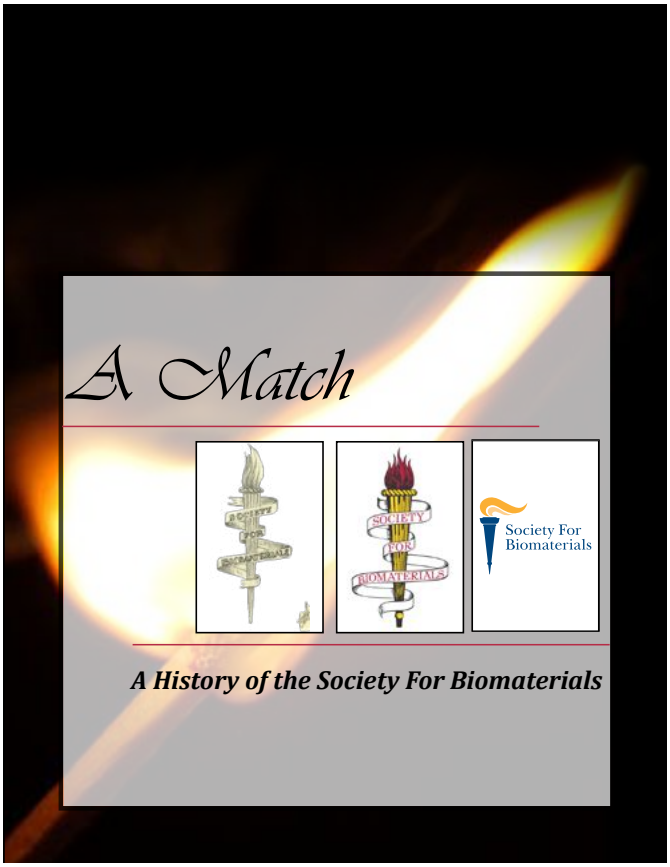

ON THE COVER
Torches throughout SFB's history

Contents

From the Editor

By Roger Narayan, Biomaterials Forum Executive Editor

It is my pleasure to share this issue of *Biomaterials Forum* with you. We are fortunate to have two feature articles that will hopefully provide you some enjoyable reading during the holiday season. Jenny Bourne, Martine LaBerge, Julie M. Gerdes and Delphine Dean authored an article entitled "Carrying the Torch," which details the early history of our society. The article describes the pivotal roles of Dr. C. William Hall and Clemson University and how they built the dynamic community that we enjoy today. I am also glad that the authors share the story of how P. Elaine Duncan helped to light the torch that continues to serve as the symbol of our society. The issue also includes an article by Otto C. Wilson, Jr. on the ABCs of biomaterials education. This article brings refreshing perspectives on biomaterials science and biomaterials education. I look forward to bringing additional thoughts from Professor Wilson to you on biomaterials research and educational activities in future issues of the *Forum*. The article also contains some timely news from Carl Simon on a recently released standard for *in vitro* testing with reconstructed human epidermis models. The use of biomaterials in alternatives to animal testing is an important and growing focus area of biomaterials research; the new guidelines will facilitate the translation of this much needed technology. I also want to thank Shena Seppanen for the staff update, John Fisher for the member news, Gopinath Mani for the industry news, Jessica M. Gluck for the tissue engineering SIG update, Antonio Merolli for the biomaterial-tissue interaction SIG update, Gerry Koons for the student chapter news and, perhaps most importantly, Carl Simon and Cherie Stabler for their overview of plans for the 2022 Annual Meeting in Baltimore, Maryland.

I would like to take this opportunity to recognize everyone who made the Forum possible this year. Chazz Scogna, who serves as managing editor, and Krista Cornew, who serves as marketing communication project manager, who provide the technical expertise in publication management that enables the *Forum* to bring the voices of the members to a diverse global community. I also would like to give thanks to the contributors, who make time in their busy schedules to bring their stories to their colleagues via the *Forum*. Finally, I would like to thank you, the reader, for bringing fresh ideas to the *Forum* in the form of articles, cover images and news stories. Please keep your ideas coming — your content is the lifeblood of the *Forum*.

Yours truly,
Roger Narayan

From the President

By Guigen Zhang, SFB President

When you read this letter, it will likely be around the winter holiday seasons. Hopefully, this year we will all celebrate the seasons with family and friends in person. So, let me first wish you happy gatherings with your loved ones! These are the family moments we used to take for granted, but the disruption by COVID-19 should remind us to treasure them once again. I am writing to get you caught up with what was going on in the Society For Biomaterials (SFB) in the past several months.

Under the leadership of Jan Stegemann, chair of the Publication committee, negotiation with Wiley on renewing the SFB/Wiley contract has completed, and a new five-year contract has been executed by the SFB and Wiley. On the committee side, of the many activities, the Biomaterials Medical Products Commercialization Special Interest Group (SIG) and Industrial Affairs Committee worked together to draft a response to Center for Devices and Radiological Health (CDRH) in regard to labeling biomaterials products. The response was reviewed by the SFB Council and submitted to CDRH in August 2021.

SFB's newest committee, the Diversity, Equity and Inclusion Committee has been very active and is making several recommendations to the Council to ensure that the SFB community remains committed to fostering an open and inclusive environment for all members of the biomaterials community. Several new initiatives have been developed and will be rolling out over the next several months.

On building SFB/FDA collaborations, the US Food and Drug Administration (FDA) drafted an MOU for the Society to consider and provide feedback. Areas for collaborations include joint workshops, webinars, Annual Meeting invited speakers and/or sessions, etc. We see such collaborative efforts as having an opportunity to serve as a bridge and provide expert opinions on developing regulatory decisions regarding biomaterials, in a consultant-like format. Moreover, the Council is also considering ways for the SFB to engage more industry members by considering the formation of a Regulatory Affairs Committee or Regulatory Affairs and Standards Committee by expanding the Industrial Affairs Committee to become an Industry and Regulatory Affairs Committee. In addition, SFB has appointed formal liaisons to the Standards Coordinating Body, who will share their activities with SFB members in future issues of the *Forum* and will report SFB input back to the SCB.

The Materials Research Society (MRS) and SFB launched, in collaboration, a webinar series delivering learning opportunities to both our members. Topics of these webinars covered translational bioelectronics, machine learning, biomaterials science and engineering to address unmet needs in women's health, etc. These webinars were spearheaded and moderated by Roger Narayan, Jonathan Rivnay, Danielle Benoit, Andrew White and Joyce Wong. Our appreciation goes to all of them. I hope some of you benefited from these webinars. Do let us know if you have any suggestions to make them better or even other ideas. SFB is also considering joining an ongoing collaboration of the American Ceramics Society, the Association for Iron and Steel Technology and the Minerals, Metals & Materials Society by partnering with them in the development and delivery of their annual Materials Science and Technology Meeting. SFB's role in this would be to develop a biomaterials track within that meeting, likely focused on hard materials.

SFB'S NEWEST COMMITTEE, THE DIVERSITY, EQUITY AND INCLUSION COMMITTEE HAS BEEN VERY ACTIVE AND IS MAKING SEVERAL RECOMMENDATIONS TO THE COUNCIL TO ENSURE THAT THE SFB COMMUNITY REMAINS COMMITTED TO FOSTERING AN OPEN AND INCLUSIVE ENVIRONMENT FOR ALL MEMBERS OF THE BIOMATERIALS COMMUNITY.

Under new Editor-in-Chief Kent Leach (UCLA) of the *Journal of Biomedical Materials Research Part A* (JBMR-A), the inaugural Early Career Editorial Board has been formed. This board consists of an international collection of outstanding early career scientists who will play an integral role in assisting the editorial board and the leadership of this journal. We look forward to seeing great things this Early Career Editorial Board will be doing to assist the JBMR-A and its Editorial Board to represent the diverse collection of investigators and research priorities of the biomaterials community in the years ahead.

The joint symposium, cohosted by SFB and the Japanese Society for Biomaterials, is in full swing and on schedule to be held on January 8-10, 2022, in Honolulu, Hawaii. While the genesis of this joint symposium was to highlight the seminal work of four pioneers in the biomaterials field and, at the same time, celebrate

From the President (continued)

their 80th birthdays — 80-plus now due to delay — of these four pioneers, the program committee also wants to celebrate the achievements by women in biomaterials with the addition of a special session highlighting Women in Biomaterials. This special session will feature Helen Lu and Tatiana Segura delivering invited talks and will provide a number of student/postdoc travel awards and will highlight some of the many achievements by women in Biomaterials at the special session.

The Foresight survey conducted by the SFB governing Board and Council has completed and the results have been summarized and discussed at the August SFB Board/Council meeting. Eleven top-rated topics have been identified including: new journal models, empowering the new workforce, higher education 3.0, empowered women, diversity and inclusion, healthcare disruption, mentoring 2.0, virtualized meetings, aging world, immigration-driven demography and population health. Continued discussions were held during the fall Board/Council meetings in mid and late November. In the meantime, active brainstorming is going on among the Executive Committee as well as various committees on how to build and deliver more values to the SFB members and to attract new members to the society.

The planning of the 2022 SFB Annual Meeting and Exposition has been moving along smoothly also. A swift review process has also been put in place with anticipated quick turnaround time for abstract review and notification of abstract acceptance. To ensure upholding of the SFB Code of Conduct, training for all session organizers and abstract reviewers have been planned and to be held accordingly.

Thank you again for your devotions and contributions to the SFB!

Best wishes, stay safe and see you in Baltimore in April 2022.

ATTENTION MEMBERS!

WE WOULD LOVE TO HEAR FROM YOU.

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

Staff Updates

By Shena Seppanen, Assistant Executive Director

Hello from Society For Biomaterials (SFB) Headquarters! The following is a summary of the actions and plans for the Board, Council and Committees.

BOARD/COUNCIL — PRESIDENT: GUIGEN ZHANG, PHD

The SFB Board and Governing Council held a two-part virtual meeting this fall, via Zoom, to discuss 2022 programming, 2022 budget, adoption of five new DEI-related proposals and potential collaborations with similarly focused organizations.

AWARDS, CEREMONIES AND NOMINATIONS COMMITTEE — CHAIR: ANDRÉS J. GARCÍA, PHD

The Awards, Ceremonies and Nominations Committee received a total of 39 award nominations and a full slate of officers to stand for election in 2022. As of this writing, Council has ratified the award recipients and the slate of officers. Officer candidate information and Award announcements will be featured in the next issue of the Forum. Thank you to all who made nominations, and please start thinking about possible nominations for next year — especially those who may have interest in serving on the Society's Board of Directors as President-Elect, Secretary/Treasurer-Elect and Member-at-Large.

BYLAWS COMMITTEE — CHAIR: C. LASHAN SIMPSON, PHD

The Committee will be reviewing the current bylaws and discussing any possible amendments.

DIVERSITY, EQUITY & INCLUSION COMMITTEE (DEI) — CHAIR: EDWARD A. BOTCHWEY, PHD

The DEI Committee developed and presented for Council approval five proposals: the creation of a new DEI Award, the inclusion of name pronunciation and pronouns in moderator instructions, a family-friendly policy for annual meeting attendees, the consideration of social justice concerns during meeting site selection, and the collection of demographic data for internal headquarters purposes only. All five proposals were discussed at length and received approval to move forward.

EDUCATION & PROFESSIONAL DEVELOPMENT COMMITTEE — CHAIR: THOMAS DZIUBLA, PHD

The Committee is planned to meet in early December to review the six applications received in consideration of Biomaterials Day grant funding.

FINANCE COMMITTEE — CHAIR: DANIELLE BENOIT, PHD

The Society's assets are down showing a direct effect of the pandemic on both membership and Annual Meeting registration in 2021. The SFB 2022 budget was approved. Please continue your support by renewing your membership and booking your accommodations for the 2022 Annual Meeting at the headquarters hotel — the Baltimore Marriott Waterfront.

INDUSTRIAL AFFAIRS COMMITTEE — CHAIR: SUPING LYU, PHD

After providing feedback to the FDA on labeling requirements, the Committee is rededicated to furthering collaborations with the FDA. They also plan to focus on discussing ways to address supply chain issues and shortages for suppliers of medical devices. The Society has also identified two active members who will act as volunteer liaisons to the Standards Coordinating Body for Gene, Cell and Regenerative Medicines and Cell-Based Drug Discovery (SCB) on behalf of SFB.

LIAISON COMMITTEE — CHAIR: BINGYUN LI, PHD

The Committee most recently engaged in a successful webinar series collaboration with the Materials Research Society (MRS) and plans to work together again with MRS to offer a virtual career discovery series this spring as well. The Committee is also considering the possibility of a potential collaboration with Materials Science & Technology (MS&T) Annual Meeting.

MEMBERSHIP COMMITTEE — CHAIR: NATALIE ARTZI, PHD

The Committee is currently focused on ways to expand the Society's reach to industry and clinicians. Their plan includes ensuring that Annual Meeting program content is attractive to these audiences by targeting speaker invitations to renowned experts in specific disciplines.

2022 ANNUAL MEETING PROGRAM COMMITTEE — CHAIRS: CARL G. SIMON, JR., PHD, AND CHERIE STABLER, PHD

The 2022 Society For Biomaterials Annual Meeting & Exposition will held in Baltimore, MD, April 27-30, 2022. The successful call for abstracts has ended and we received 704 submissions for consideration. Abstracts are currently under review and the Committee will be meeting in January to make final selections. The announcement of poster and oral presentations will be made shortly thereafter.

PUBLICATIONS COMMITTEE — CHAIR: JAN P. STEGEMANN, PHD

The Publications Committee previously conducted an extensive review and negotiation process with Wiley, the Society's publisher of JBMR Parts A & B. The five-year contract was approved by the

(Continued on page 9)

Member News

By John P. Fisher, PhD, Member-at-Large

Megan Allyn, a graduate research assistant in the Department of Chemical and Biomolecular Engineering at The Ohio State University, received the 2021 Young Investigator Student Fellowship Award for Female Scholars in Vision Research from Prevent Blindness. This award provides training support for future generations of outstanding female scientists committed to pursuing biomedical, behavioral or clinical research careers relevant to the mission of Prevent Blindness. Allyn is co-advised by Assistant Professor **Katelyn Swindle-Reilly** (Department of Chemical and Biomolecular Engineering, Department of Biomedical Engineering) and Professor **Andre Palmer** (Department of Chemical and Biomolecular Engineering).

Shaochen Chen, professor and chair of the Department of Nanoengineering and professor in the Department of Bioengineering at the University of California San Diego, and a team of nanoengineers developed a 3-D printer that rapidly produces large batches of custom biological tissues that could help make drug development faster and less costly. The high-throughput bioprinting technology can produce a 96-well array of living human tissue samples within 30 minutes. The research team noted that having the ability to rapidly produce such samples could accelerate high-throughput preclinical drug screening and disease modeling. Their work was published in the journal *Biofabrication*.

John Clegg, postdoctoral fellow in the John A. Paulson School of Engineering and Applied Sciences at Harvard University, recently accepted a position as assistant professor of biomedical engineering at the University of Oklahoma. Clegg's lab will investigate immunomodulatory biomaterials for the treatment of neurological diseases and injuries.

Mitchell Kenter graduated from Western Michigan University's medical engineering program in May. Kenter's thesis was titled, "A Novel Electroconductive Nanofibrous Scaffold for Bone Regeneration." Medical engineering is a new, two-year program focused on the interface between the traditional disciplines of medicine and engineering. The program faculty are practicing physicians from the Medical School's Departments of Orthopaedic Surgery and Surgery, including Assistant Professor **Adil Akkouch**.

Astha Khanna, head scientist in quality control and quality assurance for Graver Technologies, LLC, serves as the *Biomaterials Forum* reporter and industry representative for the cardiovascular biomaterials special interest group of the Society For Biomaterials. Khanna has been an invited speaker at several bioengineering and biomaterials conferences and has been nationally recognized at various platforms for research and leadership roles. Khanna is also recognized as the lead auditor for several ISO standards, such as ISO 9001:2015, and has been serving a critical position in the distinguished organization.

In June 2021, **Irfan Tahir**, a University of Vermont mechanical engineering PhD student, was awarded a PhD fellowship from New Harvest, a nonprofit focused on maximizing the positive impact of cellular agriculture. The three-year fellowship will provide financial support for tuition and material costs as well as a stipend. Tahir's research relates to tissue engineering plant-based scaffolds for cultured meat.

Guillermo A. Ameer, the Daniel Hale Williams professor of biomedical engineering in Northwestern's McCormick School of Engineering and professor of surgery in Northwestern's Feinberg School of Medicine, has achieved a rare, major accomplishment. A medical product based on novel biomaterials pioneered in Ameer's laboratory will be widely available for use in musculoskeletal surgeries to directly benefit patients. The biomaterial technology, called CITREGEN™, is used to attach soft tissue grafts to bone in reconstruction surgeries and provides surgeons a differentiated design.

Jaydee Cabral is a senior research fellow in the Microbiology and Immunology department at the University of Otago, New Zealand. Cabral was recently awarded as a key researcher in collaboration with the physiology department at the University of Auckland a NZ Ministry of Business, Innovation and Employment Smart Ideas Grant to develop a novel medical device to deliver therapies to the inner ear. Cabral and her PhD student Mina Rajabi were also featured in a Radio New Zealand episode of 'Our Changing World' highlighting how bioengineering is used to enhance healthcare.

Lawrence Gettleman, a professor of prosthodontics and biomaterials at the University of Louisville is the recipient of the Ryge-Mahler Award in Clinical Research in Dental Materials by the Dental Materials Group (DMG) of the International Association for Dental Research (IADR). The DMG is the oldest and largest scientific group of the IADR and awards are funded by the DMG. Gettleman's career has also included participation in clinical trial methodology in the US Public Health Service in San Francisco in the 1960s, early non-human primate research on dental implants, various small clinical trials and a large randomized controlled trial in maxillofacial prostheses at MD Anderson Cancer Center and Toronto Sunnybrook Regional Cancer Centre in the 2000s.

Christopher Jewell, the Minta Martin professor of engineering in the Fischell Department of Bioengineering at the University of Maryland, and a research biologist with the US Department of Veterans Affairs, was elected as a fellow of the Biomedical Engineering Society (BMES) at the National BMES Meeting in October. BMES fellows are recognized for impactful achievements

Member News (continued)

and significant contributions within the biomedical engineering community. They also have considerable leadership within their field of interest and have served within the society.

Sea On Lee, a PhD candidate in synthetic biology/chemistry at Johns Hopkins University, had an article published this September in ACS Central Science: Optimized Loopable Translation as a Platform for the Synthesis of Repetitive Proteins.

David Martin had his absorbable medical device manufacturer, Tepha, Inc. acquired by BD. This acquisition will expand and accelerate the access of surgeons and patients to innovative absorbable medical devices for use in soft tissue repair and regenerative medicine.

Nicholas A. Peppas is teaching a global interdisciplinary training course on principles, applications and nanotechnology innovation in pharmaceutical sciences, biological engineering and medicine. This online training program has been designed for young graduate and senior students, along with technical personnel and professors, who want to gain in-depth knowledge of nanotechnology to develop new biomedical and pharmaceutical systems or found technology-based startup companies.

Buddy Ratner, joint professor of bioengineering and chemical engineering at the University of Washington and the co-director of the Center for Dialysis Innovation (CDI) at the University of Washington, won the American Society of Nephrology and US Department of Health and Human Services KidneyX Prize. One of six winners of this international competition, the prize was awarded for a backpack-size kidney-dialysis device, conceived and being developed by a collaboration of scientists and physicians at UW Bioengineering and UW Medicine.

Staff Updates (continued from page 7)

Board and has since been signed and returned. The Committee plans to work closely with Wiley to consider ways to leverage cross promotion through the publications' platform. They are also continually considering the opportunity for additional journals and publications that may benefit the Society.

SPECIAL INTEREST GROUPS — REPRESENTATIVE: ASHLEY BROWN, PHD

Each SIG submitted budget plans for the 2022 membership year, which received approval by the Board. There are plans in the works for an all SIG social event to be held during the 2022 Annual Meeting in at Power Plant Live! in Baltimore, a spacious outdoor venue less than three blocks from our headquarters hotel with several eating and drinking options in and around the venue.

NATIONAL STUDENT CHAPTER

The National Student Chapter hosted the following webinars, "How to Host a Biomaterials Day" and "Career Opportunities in Biomaterials for HBCU Students". Stay tuned for an announcement on the next webinar opportunity.

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

Carrying The Torch

THE HISTORY OF THE SOCIETY FOR BIOMATERIALS

By Jenny Bourne, Martine LaBerge, Julie M. Gerdes and Delphine Dean
Clemson Bioengineering

Dr. C. William Hall, founder of the Society For Biomaterials (SFB), had a vision in the 1960s. He imagined an exclusive group of scientists who would come together to communicate among itself research findings and developments in the field of biomaterials science. He could not have expected that decades later, SFB would not only realize this interchange, but would also serve as a social and professional community that would produce annual publications in the field and be a catalyst for international bioengineering societies as well as national student chapters. Clemson University's contributions to the field the torchlight described in the first the editor's column from the SFB's newsletter, then called "theTorch," in which P. Elaine Duncan, editor, encourages Society members to contribute ideas regarding the future of the newsletter. A match was lit, and the torch continues to burn among the society's members, who contribute to an ever-growing and exciting community of biomaterials scientists.

HE COULD NOT HAVE EXPECTED THAT DECADES LATER, SFB WOULD NOT ONLY REALIZE THIS INTERCHANGE, BUT WOULD ALSO SERVE AS A SOCIAL AND PROFESSIONAL COMMUNITY THAT WOULD PRODUCE ANNUAL PUBLICATIONS IN THE FIELD AND BE A CATALYST FOR INTERNATIONAL BIOENGINEERING SOCIETIES AS WELL AS NATIONAL STUDENT CHAPTERS.

Several steps led to the forming of the SFB. Namely, the annual International Biomaterials Symposium (IBS) laid the groundwork and showcased the growing need for an established scholarly fraternity for the field of biomaterials. Between 1969 and 1974, the first six IBSes were held at Clemson University's Clemson House. The *Journal of Biomedical Materials Research (JBMR),* which was formed in 1967, began publishing papers from the symposia in special issues. During this time, the organization that played the largest role in the early history of the symposia outside of Clemson University was the National Institute of Dental Research (NIDR), which served as a sponsor for most of the symposia up through the second World Congress on Biomaterials and allowed symposia organizers to invite the world's leading authorities on biomaterials to speak at the IBS. This initial symposium was held January 31 and February 1. Participants, who numbered 100, heard 17 presented papers. The meeting was characterized by in-depth interchange between the clinician and the engineer; in fact, by the end of just two days, the engineer had picked up the jargon of the orthopedic surgeon. In 1970, the IBS attracted 112 participants and 16 technical presentations. The 1971 symposium marked the initial strides towards establishing a fraternity of scholars dedicated to improving the quality of life by means of improved materials of construction for artificial body parts.

In 1972, the fourth annual IBS picked up with 200 participants and 45 presented papers. Each presenter was given 45 minutes and talks resembled course lectures rather than the presentation of a single research topic. Of these 45 papers, 26 were published in *JBMR.* The 1972 symposium was also the first to include international participants, of which there were eight — a transition from an American to a truly international symposium. In addition, the much-favored tradition of a social event, the Annual Researchers' Bash (later to be known as the Biomaterials BASH) began in 1972. The symposium was divided into morning, afternoon, and evening sessions and with social events included, embraced 11 sessions in total.

During the fifth annual international symposium in 1973, the format of the meetings changed from Monday through Friday to Saturday through Tuesday. At this meeting, 87 papers were presented. Due to this large contribution, the 61 papers that were published in JBMR from this symposium were presented as two special issues of the journal. This year also marked the beginning of many SFB traditions. SFB Awards for Clinical Biomaterial Research, Basic Biomaterial Research, and Contributions to Biomaterial Literature were given; they would become known as the "Clemson Awards." On October 29, 1973, 35 biomaterials researchers met in San Antonio, Texas, at the Southwest Research Institute to discuss the organization of a society for the research of biomaterials. These researchers decided that it was time to organize, and they then created a preliminary charter and set of by-laws, electing Dr. Hall as the president. Dr. Sam Hulbert called Dr. Hall "truly the father of the Society," stating that he "is a great clinician, a great engineer and a great humanitarian."

By 1974, the symposium had become indisputably internationally integrated: The 366 participants from 29 states and 15 countries presented 101 papers, which were published in JBMR. At the

Carrying the Torch (continued)

conclusion of the sixth IBS, the SFB was formed and legalized. First, a charter for the SFB was established, then the Articles of Incorporation and Bylaws were drafted in San Antonio, Texas. The Society included 204 charter members from ten countries.

Dr. Hall and Samuel Hulbert became cofounders and the first two presidents of SFB, respectively. While Dr. Hulbert wrote that, "Dr. C. William Hall is truly the father of the Society," Dr. Hall argued in a 1988 contribution to the Society's journal. "Sam, rather than I, should have been receiving all the accolades as the 'grandfather' of our Society. Besides, he's older than I!" It is agreed that without the collaboration of both men, the society may never have become a reality.

Because Dr. Hall kept the label of the IBS for each of the Society's annual meetings, there is a six-year difference between the two labels. Many traditions of the SFB began in the early years of its existence, such as the formation of *theTorch* newsletter, which would keep members informed of the ongoings in the society and the rearrangement of annual meeting dates, something that would continue to change throughout the society's lifetime.

The Society officially began in 1975 with the first SFB meeting, which coincided with the seventh IBS. The meeting showed the society's vigor as it began to mold into itself, drawing 382 participants from 30 states and 15 countries. In all, 61 international participants traveled to Clemson to partake. The meeting had outgrown Clemson University and its resources; therefore, members decided to rotate future meetings from place to place. The purpose of the SFB meetings was clearly established then as the place in which one would present research in the field of biomaterials. In 1979, the Society returned to its birthplace, Clemson University, for its annual meeting. Here, 127 technical presentations occurred for an audience of 403 participants that included 86 students and represented 30 states and 14 countries. *JBMR* became the official organ of the SFB and The European Biomaterials Society (ESB) with its Volume XIII as Norman Cranin became the new editor-in-chief and new editor for the Society.

After more than 50 years, Clemson University remains dedicated to the field of biomaterials science and engineering and the SFB, promoting the field, educating students, conducting research and leading the community. Clemson is one of the few bioengineering/biomedical engineering academic programs in the world that awards a BS degree with the biomaterials engineering concentration. Annually, the Clemson Awards bestowed on world leaders in the field by the SFB are sponsored by Clemson's Department of Bioengineering, proudly keeping the torch lit.

CALLING ALL BOOKWORMS!

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

Society For Biomaterials 1973-2021 Clemson Awardees

1973 Basic Research	F. Leonard
1973 Applied Research	C. Hirsch
1973 Literature	S.N. Levine
1974 Basic Research	R.M. Kenedl
1974 Applied Research	J.T. Scales
1974 Literature	A.N. Cranin
1975 Basic Research	F. Rhinelander
1975 Applied Research	J.O. Galante
1975 Literature	J.L. Katz
1976 Basic Research	J.C. Bokros
1976 Applied Research	Y. Nose
1976 Literature	D.C. Smith
1977 Basic Research	J.L. Hench
1977 Applied Research	J. Charnley
1977 Literature	C.W. Hall
1978 Basic Research	R.G. Craig
1978 Applied Research	W.J. Kolff
1978 Literature	J. Autian
1979 Basic Research	J.O.M. Jowsey
1979 Applied Research	W.H. Frankel
1979 Literature	G.D. Winter
1980 Basic Research	T.M.S. Chang
1980 Applied Research	A. Wesolow
1980 Literature	J.S. Calnan
1981 Basic Research	H. Plenck
1981 Applied Research	H. Kamahara
1981 Literature	R.I. Leininger
1982 Basic Research	D.J. Lyman
1982 Applied Research	L. Sauvage
1982 Literature	R.L. Bowen
1983 Basic Research	R.E. Baier
1983 Applied Research	M. DeBakey
1983 Literature	D.F. Williams
1984 Basic Research	O. Wichterle
1984 Applied Research	V.L. Gott
1984 Literature	A.S. Hoffman
1985 Basic Research	P.N. Sawyer
1985 Applied Research	W.S. Pierce
1985 Literature	J.D. Andrade
1986 Basic Research	L. Vroman
1986 Applied Research	P. Blackshear
1986 Literature	J. Black
1987 Basic Research	S.L. Cooper
1987 Applied Research	D.B. Olsen
1987 Literature	J.M. Anderson
1988 Basic Research	S.W. Kim
1988 Applied Research	A.D. Callow
1988 Literature	A. Nakajima
1989 Basic Research	T.A. Horbett
1989 Applied Research	R.M. Pilliar
1989 Literature	B.D. Ratner
1990 Basic Research	R.S. Langer
1990 Applied Research	J. Heller
1990 Literature	E.W. Merrill
1991 Basic Research	U.M. Gross
1991 Applied Research	J.E. Lemons
1991 Literature	A.F. von Recum
1992 Basic Research	N.A. Peppas
1992 Applied Research	I.V. Yannas
1992 Literature	R.J. Levy
1993 Basic Research	M.V. Sefton
1993 Applied Research	S.R. Pollack
1993 Literature	T. Yamamuro
1994 Applied Research	F.J. Schoen
1994 Literature	J. Feijen
1995 Basic Research	J. Kopecek
1995 Applied Research	H. Brem
1995 Literature	A.M. Weinstein
1996 Basic Research	M&J Josefowicz
1996 Applied Research	J.A. Hubbell
1996 Literature	P.K. Bajpai
1997 Basic Research	T. Okano
1997 Applied Research	E. Lautenschlager
1997 Literature	J.B. Koeneman
1998 Basic Research	K.D. Cladwell
1998 Applied Research	E.P. Goldberg
1998 Literature	R. Bizios
1999 Basic Research	P.I. Branemark
1999 Applied Research	K. de Groot
1999 Literature	J. Kost
2000 Basic Research	S. Goodman
2000 Literature	J. Vacanti
2000 Applied Research	M. Refojo
2001 Basic Research	K. Park
2001 Applied Research	R.K. Li
2001 Literature	A. Mikos
2002 Literature	B.D. Boyan
2002 Applied Research	M. Spector
2002 Basic Research	J.E. Davies
2003 Literature	S.D. Cook
2003 Basic Research	J. Kohn
2003 Applied Research	T. Matsuda
2004 Literature	J. Jansen
2004 Basic Research	D.G. Castner
2005 Basic Research	K. Kataoka
2005 Literature	C. Bowman
2005 Applied Research	S. Badylak
2006 Basic Research	Patrick Stayton
2006 Literature	Cato Laurencin
2006 Applied Research	Joseph Salamone
2007 Basic Research	David W. Grainger
2007 Literature	David L. Kaplan
2007 Applied Research	Roy D. Bloebaum
2008 Literature	David Mooney
2008 Basic Research	Christi Anseth
2008 Applied Research	Jeffrey Hollinger
2009 Literature	Tae Gwan Park
2009 Basic Research	Linda Griffith
2009 Applied Research	Kazujiko Ishihara
2010 Literature	Gordana Vunjak-Novakovic
2010 Basic Research	William "Monty" Reichert
2010 Applied Research	Michael Yaszemski
2011 Literature	Ashutosh Chilkoti
2011 Basic Research	Kevin Healy
2011 Applied Research	William Wagner
2012 Literature	Molly S. Shoichet
2012 Basic Research	Andres J. Garcia
2012 Applied Research	Kam Leong
2013 Literature	Peter X. Ma
2013 Basic Research	Phillip B. Messersmith
2013 Applied Research	Elliot Lorne Chaikof
2014 Literature	Rui Reis
2014 Basic Research	Elazer Edelman
2014 Applied Research	Ravi Bellamkonda
2015 Literature	Lonnie D. Shea
2015 Basic Research	Jennifer West
2015 Applied Research	Xingdong Zhang
2016 Literature	Rocky Tuan
2016 Basic Research	Molly Stevens
2016 Applied Research	Justin Hanes
2017 Literature	Ali Khademhosseini
2017 Basic Research	Shelly Sakiyama-Elbert
2017 Applied Research	Samir Mitragotri
2018 Literature	J. Paul Santerre
2018 Basic Research	Jason Burdick
2018 Applied Research	Mark Grinstaff
2019 Literature	Balaji Narasimhan
2019 Basic Research	Paulette Spencer
2019 Applied Research	Christine Schmidt
2020 Literature	John P. Fisher
2020 Basic Research	Joyce Y. Wong
2020 Applied Research	Jeffrey M. Karp
2021 Literature	Guillermo Ameer
2021 Basic Research	Brendan Harley
2021 Applied Research	Karen Christman

The ABC's of Biomaterials Education: Through the Looking Bioglass of Idioms and Analogies

By Otto C. Wilson, Jr.
Catholic University of America

"CHOOSE A JOB THAT YOU LOVE AND YOU WILL NEVER WORK A DAY IN YOUR LIFE." — CONFUCIUS

I have a confession to make. I have spent the major portion of my career studying hard tissue biomaterials and how to enhance the healing and remodeling of bone. However, this will not be a tell all exposé of skeletons in my closet or bones in my basement. My confession is that I have been happily "unemployed" since I embarked on my career in biomaterials education and have not worked a day in all these years. The sheer joy of helping young scholars learn at their maximum potential has truly been a great reward.

I am passionate about designing better methods, strategies and resources to help people discover the fascinating field of biomaterials. Biomaterials restore function to damaged tissues and organs in the body. Biomaterials education can be used to restore function to our education system as we recover and heal from the learning lag, diversity and social justice issues that were caused and/or exposed by the COVID-19 pandemic. We can use biomaterials to develop ointments to bring healing in our education system similar to how the spice turmeric helps to ameliorate joint pain. Biomaterials education can enhance critical thinking skills, mindset, grit and perseverance in our student scholars and contribute to designing transformational learning experiences for K-16 teachers and learning coaches. An important question to address is how can these goals be achieved?

WHAT ARE ANALOGIES AND IDIOMS?

Analogies and idioms are literary tools that can be used as a source of creative inspiration to bring biomaterial lessons to life in a vibrant manner. Analogies are powerful learning tools that can help foster deeper understanding of complex phenomena and abstract concepts. The human brain is hardwired to learn from experience and analogies facilitate the formation of stronger neural bridge connections between what we know and new information that is being introduced. An idiom is a synergistic grouping of simple words whose meaning is transformed into something totally different. In this two-part article, idioms will be used to weave together thoughts and reflections to enhance the scope and impact of biomaterials education. The first part focuses on idioms based on apples, honeybees and cats and how they can be infused in biomaterials education to transform how we teach, coach, and inspire our next generation of biomaterial scholars.

A is for apple: An apple a day helps keep the doctor away

An article published in 2015 challenged this underlying premise of the health properties of apples. The results were lukewarm at best.[1] However, there is ample evidence to indicate that apples are a compact reservoir of biobased compounds that can impact various areas of health. Apples teach us that good things come in small packages. Ursolic acid is a compound found in apple peels that can increase muscle mass and shift the balance of fat in our bodies to favor brown over white fat.[2,3] Apple cider vinegar has been promoted as a healthy tonic for ages. Current products infuse apple cider vinegar into an edible gel base for daily use. This idiom highlights the importance of establishing a daily routine of good practices to contribute to long-term physical and mental health.

Apple lore holds an important place in history. Apples appear in the Bible, children's stories and Greek mythology. The tradition of giving apples to teachers dates to the 1800s. John "Appleseed" Chapman elevated apples by planting seeds and allowing them to grow and reach their full potential. Robert Schuller is credited with the following quote: "Anyone can count the number of seeds in an apple, but only God can count the number of apples in a seed." The inspirational potential that teachers can cultivate within their students is encapsulated in the following modified quote by Karen Jensen: "You can count the seeds in an apple, but you can't count the apples in a seed. When you teach, you never know how many lives you will influence — you are teaching for eternity."

Dr. George Washington Carver started his education at Simpson College in Indianola, Iowa in 1890. He majored in art and piano until his art teacher saw the beautiful drawings of plants that he created and encouraged him to apply to Iowa State University to study biology. Dr. Carver was asked to take the son of one of his professors on nature walks and teach him about plants. This mentoring relationship inspired Norman Borlaug to develop disease and draught resistant wheat seeds that saved millions of lives across the world. Dr. Borlaug received the Nobel Prize in 1970.[4]

The ABC's of Biomaterials Education: Through the Looking Bioglass of Idioms and Analogies (continued)

B is for bee: Busy as a bee

Honeybees are fascinating. We can learn a lot from them to enhance our teaching. Honeybees play a critically important role in pollinating apple blossoms to help the apple develop and mature. The idiom, "Many hands make light work" or the bee version, "Many wings make light work" highlights the importance of teamwork. The nectar from 2,000,000 flowers is required to make one pound of honey. The average honeybee will make about one-twelfth (1/12) of a teaspoon of honey in her lifetime.[5]

Honeybees provide great inspiration for learning about planning, teamwork, architecture design, math and engineering for scale up related to honey production and storage (Figure 1). One classroom of 25 young scholars (8 to 10 years old) in England published an article about their classroom study of how bumble bees perceive color.[6] Honeybees can teach valuable lessons related to the sting, flight, honey and dance that we can model to enhance our teaching. The bee-sting is very memorable and can provide insight for the design of needles due to its functionally graded structure. Honeybees have a unique movement of their wings which generates double the lift and conserves energy. Honey can serve as a wound healing agent and sweeten lessons learned. Honeybees use dance to communicate information about the location of flowers. These concepts were developed into a series of professional development workshops and shared with a group of pre-service and in-service teachers for the Transforming and Innovative Practices in STEM (TIPS) program at Medgar Evers College in Summer 2020 and 2021. The content was further refined as part of a CUA Center for Teaching Excellence (CTE) Fellowship in 2021 with Instructional Coach Dr. Aranzazu Ascunce. CTE is directed by Dr. Angela McRae and her wonderful coaches and staff.

When life hands you lemons, make lemonade

Recently, there has been a lot of buzz (no onomatopoeia pun intended) about bees related to colony collapse disorder (CCD). CCD poses a serious threat to honeybee and human survival. When life handed Mikaila Ulmer lemons when she was stung by a bee at age 5, she transformed that experience into a multimillion dollar honey sweetened lemonade empire where she is the queen bee. She recently published her first book entitled Bee Fearless: Dream Like a Kid. Mikaila's story is inspiring many young scholars to learn about bees, take calculated risks, and "bee" successful entrepreneurs and scholars from a young age.

C is for cat: Curiosity killed the cat

I don't like this idiom and I suggest to change it to, "Curiosity inspired the cat to discover great things!" How do we cultivate creative curiosity and foster the innate ability of our young scholars to ask key questions to address health challenges that we face as a society? In 2016, the Office of the State Superintendent of Education (OSSE) in DC awarded us a Department of Education Teacher Quality Improvement (TQI) grant entitled Propagating Inspiring Questions to Uncover Excellence in Education by Design (PIQUED) Curiosity. We developed the concept of a virtual time machine to transport students and teachers to key points in history to explore key questions, understand the culture and context which gave birth to the questions, and catalog the new questions created in answering the original question.

Figure 1. Illustration displaying various aspects of the busy life of Honeybees as they engage in planning and building their hive home. (Creative concept conceived by and permission granted from Dr. Gunnar Lucko, Civil Engineering Professor at the Catholic University of America)

The ABC's of Biomaterials Education: Through the Looking Bioglass of Idioms and Analogies (continued)

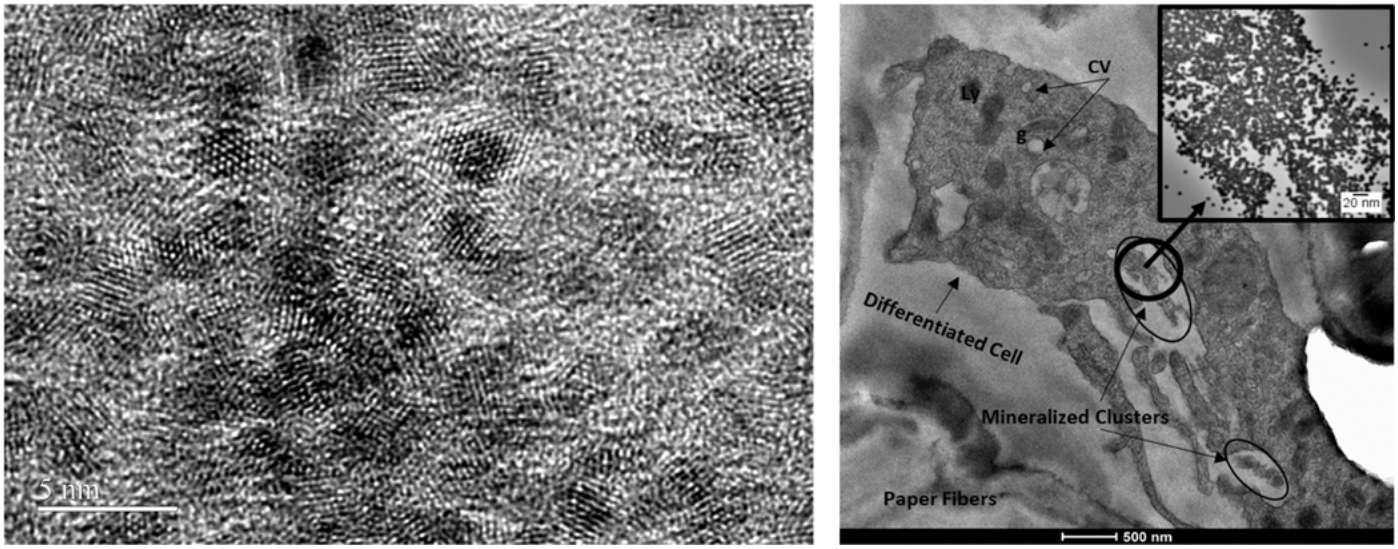

Figure 2. Electron Micrographs showing a) single crystal hydroxyapatite particles and b) amorphous particles produced by osteoblast differentiated MC3T3 – E1 cells cultured on cellulose tissue paper scaffolds.

BIOGLASS, BOING BOING THE BIONIC CAT AND OTHER WAYS TO INSPIRE CURIOSITY

I remember spending much time in my youthful days watching cartoons and reading comic books. Cartoons brings the idiom a picture is worth a thousand words to a higher level of inspiration. Dr. Larry Hench helped me connect my long term passion for reading and comics with my research passion, bone and biomaterials education through the medium of Bioglass. Dr. Hench also created a wonderful children's story series featuring Boing Boing the Bionic Cat. Boing Boing was invented by a professor for a young boy who was allergic to animals. Boing Boing has fiber optic fur, piezoelectric sensors and a host of other ceramic components which allows him to go on learning adventures with his friend.

People who live in bioglass houses should not throw kidney stones

Bioglass was designed by Dr. Larry Hench in the late 1960s. He added calcium and phosphate ions to a glass formulation and discovered the first manmade material that could bond with bone and soft tissue. Bioglass revolutionized many aspects of Biomaterials education. While I was in graduate school at Rutgers University, I enrolled in a class about the properties of glass. We were assigned to write a research paper. I wanted to write a paper related to my dissertation topic electronic ceramics but Dr. George Siegel wisely said no and encouraged me to select a different topic. I was upset at first. Little did I know that closing one door would open another wonderful door of opportunity. I discovered bioglass and this topic resonated with my long term interest in chemistry and newly discovered passion for bone. This "road less travelled" that I took is still reaping great rewards.

I learned about biomineralization phenomena and the nucleation and growth mechanisms that are used to control the degree of crystallinity of hydroxyapatite. Ca10(PO4)6(OH)2 is the model formula for the mineral phase in bone and teeth. This introduced me to the field of biomimetics and I was able to use these ideas to complete my PhD. dissertation. Biomineralization is still a major aspect of my research program in the Biomimetics, Origami Orthopedics, Nanomaterials Education/Composite Research for Advanced Biomaterials (BONE/CRAB) Lab. We focus on the synthesis, surface modification and characterization of hydroxyapatite. Our team has been able to produce nanoscale hydroxyapatite single crystals grown in vivo in Sprague Dawley rats (Dr. Tiffany Omokanwaye with follow-up crystallography studies by Abdulelah Alrebaish) and completely amorphous calcium phosphate grown on tissue paper scaffolds by osteoblast cells (Loaiza Maldonado-Mateo) that are reminiscent of Posner's Clusters (Figure 2).

Sticks and stones (and unicameral bone cysts) may break my bones: Otto's broken leg and WishBone Willie

I was extremely blessed to be awarded an NSF Early CAREER Award in 2007 for my proposal Bone Inspiration in Research and Education. The research program highlighted the use of crab shell to stimulate bone growth. This idea is based on the ancient Mayans use of nacre to replace missing teeth. I included a substantial amount of K-12 education outreach in my proposal featuring a model to link aspects of bone health with our education system and developed an animated mascot for the BONE/CRAB Lab named WishBone Willie. Life threw an unexpected curve ball in my direction during the first year of my

The ABC's of Biomaterials Education: Through the Looking Bioglass of Idioms and Analogies (continued)

CAREER Research Project. Both of my sons, Otto III and Daniel, have been wonderful sources of inspiration for my wife, Debbie, and me. My oldest son Otto III developed a unicameral bone cyst in his left femur that spontaneously fractured in November of 2007 right around Thanksgiving time. Figure 3 shows the X-ray images of the non-union fracture. I was able to experience a serious bone injury and the ensuing healing process through the eyes of my son. It adds untold levels of motivation to your life work when your research can directly impact someone that you love very much. Otto wrote about his experience and illustrations created by Mary Luongo Weyrick (Figure 4).

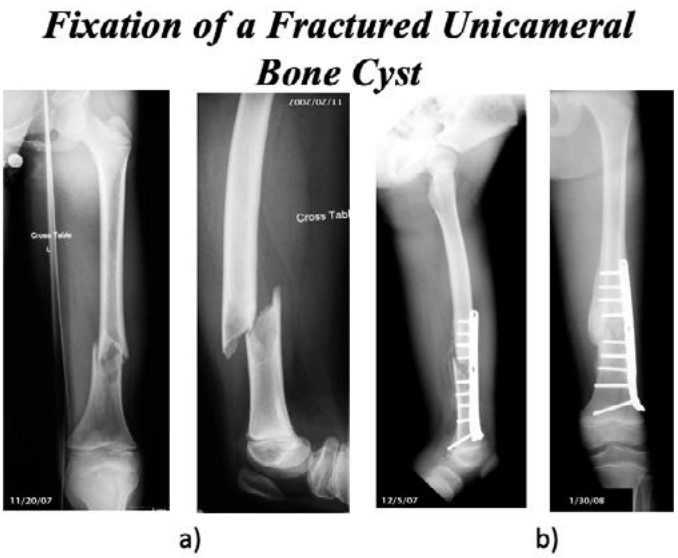

Figure 3. Spontaneous femur fracture due to a unicameral bone cyst. a) Front and side view of the fracture before intervention b) Two weeks post op showing bone callus formation and titanium plate and screw fixation biomaterials.

Figure 4. a) Illustration of WIshBone Willie, Otto III and Daniel on the first day that they met following Otto's femur fracture. B) WishBone Willie explaining aspects of bone healing. (Illustrations created by Mary Luongo)

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Government News

LANDMARK STANDARD PUBLISHED ON USE OF RECONSTRUCTED HUMAN EPIDERMIS FOR SKIN IRRITATION TESTING

By Carl Simon, Government News Editor

A landmark standard for in vitro testing was recently published entitled "ISO 10993-23 Biological Evaluation of Medical Devices: Tests for Irritation."[1] This 68-page document addresses skin irritation tests using in vitro models reconstructed human epidermis (RhE), animals or human volunteers. It covers liquids, solids, extracts of solids and powders. Detailed protocols and many useful references are provided to help improve consistency and comparability in skin irritation testing.

RhE is created with normal human keratinocytes in multiwell plates with cell culture inserts containing membrane filters. Cells are cultured on the membranes at the air-water interface and are matured in a chemically defined medium to generate a multi-layered and differentiated model of human epidermis. RhE can be obtained from vendors and there are a number of markers that can be measured to confirm their differentiated status.[2,3] Tests are conducted by placing irritants on the RhE and then measuring cellular metabolic activity using the MTT test [3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyl-2H-tetrazolium bromide]. Reproducibility of RhE skin irritation tests has been assessed by interlaboratory studies.[4]

Perhaps the most interesting aspect of in vitro RhE tests is that they can be validated by clinical trial.[5] Skin irritation studies are "relatively" easy to conduct in humans due to reduced ethical concerns. Irritants can be placed on the skin for a few hours at low risk to the volunteer. In contrast, consider validation of a cardiac microphysiological system for testing drugs to treat heart ailments. A trial to intentionally assess cardiac toxicity with no direct benefit to the subject would probably be deemed unethical due to safety concerns and potential harm to the volunteer.

A strength of the standard is that it provides information on positive and negative controls. For example, a 20% solution (mass/volume) of sodium dodecyl sulfate (SDS) is recommended as a positive control for liquids for skin irritation for humans since its effects have been well characterized.[5] Another example is sterile gauze as a negative control for solids. SDS and gauze are convenient since they are widely available, homogenous and stable.

Two other organizations played a key role in this success. The Organization for Economic Co-operation and Development (OECD) is a standards development organization that focuses on chemical hazards and has been instrumental in advancing documentary standards for in vitro skin tests.[6] In addition, the European Union Reference Laboratory for alternatives to animal testing is the European Centre for the Validation of Alternative Methods (EURL ECVAM). Their mission is to advance the "Three R's": replacement, reduction and refinement of animal procedures. EURL ECVAM helped organize several interlaboratory studies to assess the reproducibility of in vitro skin models.

This standard represents a truly remarkable advance in biomaterials science. It provides a playbook that emerging technologies might follow to achieve quality. For instance, microphysiological systems (MPS) and organ on a chip (OOAC) devices are being advanced for assessing drug toxicity and efficacy, and these systems will need to undergo a similar process of interlaboratory testing, validation and establishment of accepted positive and negative controls. Now that success and market acceptance have been achieved for skin models, the pathway for other technologies is partially illuminated. We now have confirmation that it is not impossible to validate an in vitro tissue model! Stakeholders in MPS systems could take note and treat this as a case study to see what strategies can be used or modified to advance other systems.

ISO 10993-23 can be purchased for ₣193 Swiss francs ($193 USD).[1] The cost may seem high, but the funds support the fair and open process used for ISO standards development which includes staffing (editors, statisticians, program managers) and support services such as websites and meeting organization where the working groups discuss ongoing projects. Standards such as this are difficult to organize and execute and can take 5 to 10 years from concept to publication. Precise wording is required to acknowledge the limitations and caveats of the methods, so that the results are not overstated, and the test results are not over-interpreted. Many stakeholders from a wide variety of organizations have to achieve consensus including researchers, testing device manufacturers, medical device manufacturers, regulators, physicians and patients. Achieving this level of consensus takes a lot of effort and can be an exercise in herding cats!

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Industry News

By Gopinath Mani, Industry News Editor

Johnson & Johnson Vision recently received approval from Health Canada for ACUVUE® Abiliti™ 1-Day Soft Therapeutic Lenses for Myopia Management.[1] Abiliti™ 1-Day lenses are a new option of daily wear, single-use, disposable lenses that have the potential to slow the progression of myopia and are specifically designed for children who are 7 to 12 years old at the start of treatment.[1] Myopia (nearsightedness) is a chronic and progressive disease that poses the biggest eye health threat of the 21st Century.[1] Half of the world's population is projected to be myopic by 2050 with nearly one billion people expected to have high myopia.[1] Children under 12 who are diagnosed with myopia are at greater risk of developing high myopia which may lead to sight threatening disease later in life.[1] Abiliti™ 1-Day lenses are not traditional concentric ring presbyopic design lenses.[1] Abiliti™ 1-Day lenses are built from silicone hydrogel lens material and are specifically designed to slow myopia progression in children and have been shown to reduce axial elongation by 0.105mm on average over a six-month period.[1]

Bionaut Labs, a company focused on the treatment of central nervous system (CNS) disorders with its Bionaut™ precision medicine treatment modality, recently announced that the Food and Drug Administration (FDA) has granted the Company humanitarian use device (HUD) designation for BNL-201 for the local treatment of Dandy Walker Syndrome, a rare pediatric neurological disorder.[2] Dandy Walker Syndrome is a congenital brain malformation usually diagnosed in childhood.[2] It varies in severity and may cause a wide range of symptoms, including intellectual disabilities, delayed motor development, muscle stiffness and partial paralysis, seizures, hearing loss, and vision problems.[2] The only treatment options available today involve invasive intracranial surgical procedures and are prone to infections and complications, and many patients with Dandy Walker Syndrome suffer from shorter life spans with poor quality of life.[2] BNL-201 offers a minimally invasive local microsurgery procedure to fenestrate the cyst that causes this condition and eliminate surgical trauma, to restore patient brain function and development.[2] A HUD designation is intended to benefit patients in the treatment or diagnosis of a condition that affects less than 8,000 people in the United States per year.[2] The FDA's HUD program is an alternative pathway for getting market approval for medical devices that may help people with rare diseases or conditions like Dandy Walker Syndrome, which affects only one out of every 25,000 to 30,000 people.[2]

Dexcom, Inc., a leader in real-time continuous glucose monitoring (CGM), recently shared that people with type 1 diabetes who are 25 years of age or under may now be eligible for provincial coverage of the Dexcom G6 CGM System through Manitoba Health and Seniors Care.[3] The Dexcom G6 CGM System includes a small, wearable sensor that measures glucose just below the skin; a transmitter to send glucose levels continuously and wirelessly to a display device; and a compatible smart device or receiver that displays real-time glucose data to users without the need for fingerstick or scanning.[3] The Dexcom G6 provides users with real-time alerts, including a predictive Urgent Low Soon alert, and can warn the user in advance of hypoglycemia, giving them time to take appropriate action before it occurs.[3] With the use of the Dexcom Follow app, parents and caregivers can also access their loved one's glucose levels remotely and be alerted if they are going out of their target glucose range.[3]

Evren Technologies, Inc. recently announced that its non-invasive Phoenix® earbud device received Breakthrough Device Designation from the FDA for the treatment of post-traumatic stress disorder (PTSD).[4] The goal of the Breakthrough Designation Program is to help speed the development and shorten review time of medical devices with the potential to provide more effective treatment for life-threatening or irreversibly debilitating diseases.[4] A key requirement for the Designation is preliminary clinical evidence demonstrating substantial improvement on a clinically significant endpoint compared with other available therapies.[4] Every year, 7.5 million Americans seek treatment for PTSD and the rates tripled during the COVID shutdown.[4] The Phoenix is an earbud that provides personalized medicine that addresses the underlying autonomic imbalance of PTSD by delivering transcutaneous auricular vagal nerve stimulation (taVNS) in a proprietary closed-loop system.[4]

BD (Becton, Dickinson and Company), a global medical technology company, recently announced that it has received 510(k) clearance for expanded indications from the FDA for the Rotarex™ Atherectomy System.[5] Peripheral arterial disease (PAD) is a potentially debilitating disease that can lead to increased risk of cardiovascular complications and limb amputation.[5] The development of PAD includes the formation of atherosclerosis and thrombus in arteries in the legs.[5] The treatment of PAD may be necessary if the arteries are blocked.[5] Atherectomy and thrombectomy are minimally invasive techniques that use a catheter to remove the plaque and blood clot buildup, respectively, to increase blood flow through the diseased areas.[5] The Rotarex™ Atherectomy System is a rotational excisional device that is built to remove and aspirate varying lesion morphologies including plaque and thrombus in the peripheral arteries.[5] The unique mechanism of action of Rotarex™ Atherectomy Device has enabled the simultaneous treatment of both plaque and thrombus.[5] The Rotarex™ System, already

Industry News (continued)

cleared for use in native arterial vessels, now has the expanded indications to treat within peripheral arteries fitted with stents, stent grafts, and native or artificial bypasses.[5]

B dot Medical Inc. has conducted an energization test of the scanning magnet for a compact proton cancer therapy system under development and confirmed the generation of a magnetic field.[6] That means a major step forward in the realization of high-speed scanning irradiation and respiratory-gated irradiation on a proton cancer therapy system.[6] In recent years, the scanning irradiation method has been commonly used in proton therapy.[6] The method in which a narrow proton beam is scanned according to the shape of tumors can minimize damage to normal tissues and organs around the tumor.[6] In addition, it is required for high-speed and accurate scanning to irradiate tumors that move with breathing (e.g., lung, liver).[6] B dot Medical has completed the manufacture of a compact, high-speed scanning magnet that is the first of its kind in proton therapy.[6] Conventional systems require two magnets and a long distance to scan the beam in horizontal and vertical directions to the tumor, but this magnet can scan in both directions, and the distance from the irradiation system to the irradiation position has been successfully reduced to about one-third that of the conventional one.[6] The scanning magnet, which has been drastically downsized, has the same or higher level of capability to scan at high speed than conventional ones, and can also be used for respiratory-gated irradiation, which can irradiate tumors that move with breathing.[6]

Venclose Inc., a medical device company focused on innovative treatment procedures for venous reflux disease recently announced the FDA 510(k) clearance for Venclose Maven™, a novel radiofrequency ablation (RFA) catheter for minimally invasive treatment of incompetent perforator veins (IPVs).[7] Venclose is developing next-generation solutions for the treatment of venous reflux disease, also known as chronic venous insufficiency (CVI), which is a progressive medical condition affecting more than 40 million adults in the United States alone.[7] The Venclose System is the next-generation endovenous RF ablation system designed to close the damaged vein and restore healthy blood flow in patients with venous reflux disease, a progressive medical condition which is often associated with varicose veins.[7] The Venclose Maven is engineered to facilitate vein wall contact via both segmental and circumferential thermal delivery.[7] These performance features were applied with the knowledge that physicians already familiar with this ablation method could quickly and easily incorporate the Venclose Maven catheter into their practices for IPV treatment.[7]

Computed tomography (sometimes called computerized tomography) is a noninvasive medical examination or procedure that uses specialized X-ray equipment to produce cross-sectional images of the body.[8] These cross-sectional images are used for a variety of diagnostic and therapeutic purposes.[8] The new diagnostic imaging device, called Siemens NAEOTOM Alpha, is designed to transform the information from X-ray photons that pass through a patient's body and are received by a detector into a detailed 3-dimensional image.[8] The device uses the emerging CT technology of photon-counting detectors which can measure each individual X-ray that passes through a patient's body, as opposed to current systems which use detectors that measure the total energy contained in many X-rays at once.[8] By counting each individual X-ray photon, more detailed information about the patient can be obtained and used to create images with less information that is not useful in the review and analysis.[8] The images delivered by the system can be used by a trained physician as an aid in diagnosis, treatment preparation and radiation therapy planning.[8] The FDA reviewed the Siemens NAEOTOM Alpha through the 510(k) premarket clearance pathway.[8] A 510(k) is a premarket submission made to the FDA to demonstrate that a new device is substantially equivalent to a legally marketed predicate device.[8] The FDA granted clearance of Siemens NAEOTOM Alpha to Siemens Medical Solutions Inc.[8]

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Tissue Engineering SIG Update

Jessica M. Gluck, PhD

It has been a CRAZY two years! I think we can all agree that we are tired of hearing the word "unprecedented!"

Luckily for us, the Tissue Engineering SIG has responded to the COVID-19 global pandemic as expected — rising to the challenge and exceeding expectations. Throughout the larger Society for Biomaterials, we have witnessed students graduate, new faculty appointments and promotions during this challenging time and we want to highlight how our Tissue Engineering SIG members have overcome the additional challenges the last two years have brought.

Two graduate students from NC State University who recently presented their work at the Annual Meeting this past April discussed how the pandemic has affected them.

Fan Zhang, a PhD candidate working on a project to engineer an immunomodulatory textile/hydrogel composite vascular graft said, "During the pandemic, what I found most challenging was when all the lab works were suspended because of the shutdown. It was mostly the mental stress and the anxiety when we were held back yet there was nothing we can actually do about it. Although we are open now, we are still experiencing back order of experimental materials and elongated ordering and waiting time. What I learned from this experience is that we have to plan way ahead than we were, multitask, be patient, and always see the positive side of things. While waiting on experiment materials, I was able to read literature, analyze data, prepare manuscripts and plan ahead for the next steps in the research, which helped to relieve my anxiety and hopeless feeling to a great extent. The long waiting time also actually helped me to step back into my life and catch up on hobbies."

Kiran Mumtaz completed her MS degree in December 2020 and is continuing her graduate studies as a PhD student working on fibrous scaffolds for tissue engineering found her work during the pandemic to be challenging, but is feeling encouraged now. "Working in a new lab in a global pandemic was a challenge, especially when we had to learn the lab procedures with nothing but a written copy of the protocol. I don't think I will ever forget my first cell culture — only one in the entire building, working with the tools that were all alien to me. However, these unprecedented problems required unprecedented solutions. The pandemic helped us realize how unprepared we were, and since then our lab has made videos and graphical protocols for common laboratory procedures which I am sure all the new lab members appreciate."

Within our Tissue Engineering, we have witnessed several impressive transitions during the extra challenge of navigating the faculty search during a pandemic. In particular, Dr. Brian Aguado moved on from his position as a postdoctoral scholar working with the Anseth Research Group at the University of Colorado at Boulder. Dr. Aguado is now an assistant professor of bioengineering at UC San Diego (UCSD) and a faculty member of the Stanford Consortium for Regenerative Medicine. He is in the process of setting up his new laboratory and recruiting members with a research program focused on studying sex differences in cardiovascular disease using biomaterial technologies. He was recently awarded the Biomaterials Diversity Award for Young Investigator and was recognized as an outstanding Hispanic/Latinx scientist by *Nature Biotechnology.* When asked about making such a big career change during a global pandemic, Dr. Aguado said, "Reset your expectations — there are things out of your control (equipment backorders, lack of in-person networking, etc.) that make the job so much more challenging but are simply not worth stressing out over. I am also trying to keep the job fun with lab outings with my students in the San Diego area, and taking up local hobbies (surfing, kayaking, restaurants, etc.). It is also super important to work somewhere that you also enjoy living in — UCSD is a dream come true, and living in San Diego is a perfect and enriching fit for my personal life. Being a professor is just one page in my life book — there are so many other things to explore and enjoy!"

Exciting research and innovative strategies to share progress have also been fruitful outcomes of the last two years. Dr. Ngan F. Huang at Stanford University recently launched her engineered skeletal muscle tissue to the International Space Station as part of a study to model the effects of microgravity on muscle wasting. As a way for my group to stay connected, I started a virtual biweekly tissue engineering seminar series. We have had the privilege of hosting many of the Tissue Engineering SIG members and highlight student work several times each semester. We hope you will join us and share your work in the future.

On behalf of the Tissue Engineering SIG, I hope everyone is faring well and happy to be back in the lab. We all look forward to the upcoming meetings in Hawaii and Baltimore and hope to see everyone in person soon!

Biomaterial-Tissue Interaction SIG Update

By Antonio Merolli, MD, FBSE

We celebrated the 2021 Society For Biomaterials (SFB) Annual Meeting in Chicago, Illinois … virtually. Going virtual was quite a last-minute option, but it was necessary. For those of you who (like me) are waiting for an in-person meeting, let's aim for the 2022 SFB Annual Meeting in Baltimore, Maryland.

We had our Biomaterial-Tissue Interaction SIG (BTI-SIG) virtual session in Chicago, and it was successful. The online modality makes these sessions a kind more private, very different from the first crowded BTI-SIG meeting I attended years ago. (But at least you do not risk to find no seat, as it happened frequently in our past meetings.)

In 2021 we had elections too. Rene Olivares-Navarrete from Virginia Commonwealth University was confirmed Program Chair. Omid Veiseh from Rice University became the new Vice-Chair. Sunita Ho from University of California San Francisco was elected new Secretary/Treasurer.

Finally, I became your new Chair.

We thank all the BTI-SIG members who actively participated in the ballot! We will do our best to keep the BTI-SIG improving and growing (we are already the third-largest SIG group of the SFB). A hearty thanks goes to our past Chair Floyd Karp from Washington University. He devoted so much effort for the well-being of our group. It will be a challenge to keep up with his standards. We will try.

We are preparing for the 2022 SFB Annual Meeting! We will have our BTI-SIG session and we will also co-sponsor a session on "Biomaterials for Pancreatic Islet Replacement and Immune Tolerance in T1D," proposed by Ed Phelps and Andres Garcia. Our 2021 budget will be focused on acknowledging excellence in science at the 2022 SFB Annual Meeting. We will confer three prizes for the best posters ($50 each) and three for the best oral presentations ($100 each).

We hope to see you in large numbers in Baltimore! And, stick around: We will have a small surprise for our members.

Student Chapter News

By Gerry Koons

Welcome to our newly elected 2021-2022 Bylaws Chair, Meghana Shivanada Murthy!

Meghana H. Shivananda Murthy is a PhD student in the quantitative bioscience and engineering program under the chemical and biological engineering department at Colorado School of Mines in Golden, Colorado. She is working in the biomaterials- and engineering-based laboratory of Dr. Nikki Farnsworth. Her research centers on the interactions of pancreatic islets with immunomodulatory biomaterials based on extracellular matrix components, to develop protective therapies against the onset of Type 1 diabetes.

David Eduardo Flores Prieto (Arizona State University) will also serve as our President-Elect, and Nicholas Fischer, PhD (University of Minnesota) as our Secretary/Treasurer-Elect, with upcoming terms in the 2022-2023 academic year. These election results were announced at our fall National Student Section meeting.

We initiated our new effort to hold quarterly meetings with the local university chapters on September 8, with a workshop on planning Biomaterials Day events facilitated by our Secretary-Treasurer Bryan James, PhD.

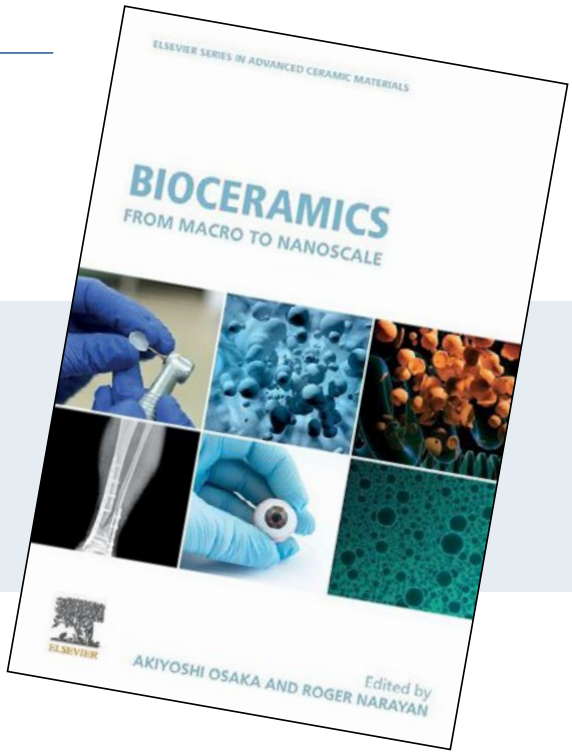
We recently held a webinar on Career Opportunities in Biomaterials for HBCU Students. You can access the recording here. Please stay tuned for more information on our upcoming webinar discussing best practices for creating impactful figures for papers, websites, and beyond!

Follow us on our new Instagram *@sfbstudents* and expanded Twitter *@sfb_students* – or contact us through our new Gmail address: **sfbstudents@gmail.com**

Bioceramics: From Macro to Nanoscale

A VOLUME IN ELSEVIER'S SERIES ON ADVANCED CERAMIC MATERIALS

By Lynne C. Jones, PhD and Liisa Kuhn



Edited by: Akiyoshi Osaka and Roger Narayan
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ISBN: 978-0-08-102999-2

Bioceramics: From Macro to Nanoscale successfully provides the reader with an overview of what is currently known, as well as a glimpse of the future, regarding the application of bioceramics to medicine. Chapters have been written by authors from throughout the globe, including authors from China, Germany, Italy, Japan, New Zealand, Turkey and the US, providing an international perspective on the topic. There is increasing interest in the use of nanomaterials to increase interactivity of bioceramics with cells, proteins, and even genes. This book, as the title implies, covers the full range of bioceramic compositions and surface modifications that greatly influence biological behavior depending on their scale. Chapter 1 provides a brief introduction to the book and pays tribute to the pioneers in the field who introduced us to bioglass and calcium phosphate deposition techniques used in bone substitutes and bioactive ceramics.

The book is divided into nine parts each with multiple chapters.

PART ONE: NANOSTRUCTURED SURFACES, SURFACE BIOMEDICAL MODIFICATIONS OF MATERIALS

There are different technologies that can be used to accomplish surface modification of nanoparticles which are well-described in Chapter 2. Chapter 3 expands on this topic in its description of nanostructured TiO_2 layers on titanium (Ti) and Ti alloys. The primary interest early on regarding surface modification of Ti alloys was to understand how it facilitated bone bonding to improve fixation of dental and orthopaedic implants. Current studies now include applications regarding bacterial inhibition and the modulation of immune responses. Chapter 4 describes non-orthopaedic applications including the use of Fe_{3O4} or γ-Fe_{3O4} nanoparticles as MRI contrast agents and Fe_{3O4} nanoparticles for cancer hyperthermia treatment.

PART TWO: NANOPARTICLES FOR DRUG DELIVERY APPLICATIONS, SENSING AND DIAGNOSTICS

Chapter 5 introduces us to the application of rare-earth doped ceramic nanoparticles (RED-CNPs) to drug delivery, sensing and diagnostics. This chapter is interesting as it goes through the process of the research and development of RED-CNPs. It explains the limitations of other techniques used to excite a phosphor for visible fluorescence. It then explains the long luminescence lifetimes of rare-earth ions over dyes, quantum dots and carbon nanotubes. This is followed by a description of synthesis and surface modification of RED-CNPs. This chapter ends with descriptions of the impact of deep tissue NIR fluorescence with the development of InGaAs CCD cameras, photodynamic therapy, and nanothermometry. Chapter 6 describes how organic-inorganic nanohybrid particles can be formed which exploit their intrinsic properties as well as work together synergistically. This chapter introduces us to cerasomes, which may simulate cell-like structures and can be used for gene delivery, and to stimuli-responsive hollow capsules that can be used for drug delivery in response to external stimuli (e.g., lights, magnetic fields).

PART THREE: NANO-SCALE EFFECTS ON BIOCERAMICS; MOLECULAR NANOSTRUCTURE CONTROL

Chapter 7 focused on inorganic-layered compounds, specificially octacalcium phosphate (OCP), layered double

Bioceramics: From Macro to Nanoscale (continued)

hydroxides (LDHs) and layered phosphatases. The authors provide details of material characterization and potential medical applications. They inform us that LDH can intercalate various inorganic and organic anions, creating a "microvessel" for drug storage. Layered phosphates can be created with tetravalent metals which can intercalate ammonium ions and amines. Medical applications include delivery of anticancer drugs and insulin. Chapter 8 describes the transform reaction of dicalcium phosphate dihydrate (DCPD) with fluoride ions to create nanoapatite formation on DCPD particles. Of interest is its antibacterial properties and application to dental implants. Chapter 9 describes the need, synthesis and use of bioinspired calcium phosphate (CaP) composites as substitutes for bone graft to fill and promote healing of bone defects. Conventional techniques and 3D bioprinting are used to create the implants and a table lists the advantages and disadvantages of various biomaterials (i.e., metals, bioceramics, polymers) in bone engineering. Chapter 10 presents the application of bioceramics to apheresis (i.e., blood purification therapy) used in medical procedures such as rheumatoid arthritis and sepsis. Titania and hydroxyapatite, shown to be blood compatible, have been introduced to overcome the thrombogenic properties of many materials used in medical devices. Another application of bioceramics is the use of silica-doped calcium carbonates and their composites as bone fillers to promote bone healing, as detailed in Chapter 11. Vaterite is a crystalline polymorph of calcium carbonate which can be stabilized with siloxane. Vaterite particles can further be doped with silicate, Ca^{2+} or Mg^{2+} ions that stimulate ALP activity in osteoblast-like cells.

PART FOUR: BIOINERT BULK CERAMICS; LOAD BEARING CERAMICS

Ceramics have also been used in the construct of orthopaedic implants, including hip and shoulder arthroplasty. Chapter 12 begins with a review of the history of research and development of oxide ceramics as applied to total hip arthroplasty. It follows with a discussion of the importance of material selection and how the use of ceramics for hip arthroplasty prostheses overcomes the limitations of traditional materials (i.e., metals) used for arthroplasty prostheses, including corrosion, metal ion release, wear and the generation of wear debris and even the risk of periprosthetic infection. Chapter 13 is different from the proceeding chapters in that it presents a series of experiments to characterize two bioceramics (Al_{2O3} and Si_3N_4) which heretofore were considered bioinert. One take-away is the point that bioceramics have been labeled bioinert despite the paucity of studies regarding the "molecular interaction between bioceramic substrates and the organic constituents of cells (e.g., phospholipids and triphosphates." This has implications regarding cell function as well as cell metabolism and viability.

PART FIVE: ADDITIVE MANUFACTURING; AMORPHOUS MATERIALS

Chapter 14 focuses on the use of robocasting of mesoporous bioactive glasses (MBGs) to create scaffolds for bone tissue engineering. They define robocasting as a layer-by-layer additive manufacturing technique which can be used to produce a synthetic scaffold with a microporous structure and defined mechanical properties. Potential medical applications include bone defect fillers as well as encapsulation for controlled release of drugs and bioactive molecules. A detailed description of the robocasting technique is presented. This chapter also provides a glimpse of the future with a discussion of recent technological advances in mesoporous bioactive glass robocasting.

PART SIX: CERAMICS IN DENTAL APPLICATIONS; GLASS-CERAMICS, CEMENTS, GLASS-IONOMERS

Chapter 15 provides a solid overview of three types of bioglasses (BG): melt-derived, sol-gel derived, and ordered mesoporous sol-gel derived. The advantages and limitations of each are well-described. The section on the combination of melt-derived and mesoporous bioglasses described how the resultant material benefits from the mechanical properties of melt-derived BG and the improved nanostructure of mesoporous BG. The other dental materials topics in the title of part six are not included in the current volume of the book (i.e., cements, glass-ionomers).

PART SEVEN: BIOACTIVE CERAMICS

Chapter 16 examines bioactive ceramics and notes that the mechanical properties, composition, affinity for bone tissue and final shape define their translatability to medical applications. The authors note that we have raised the bar and would like to maximize the biological functionalities, including antibacterial properties, stimulation of osteogenesis and controlled bioresorbability. Bioactive ceramics reviewed include calcium phosphate ceramics, bioglass, glass-ceramic A-W (apatite and wollastonite). The chapter also describes more recently developed bioactive ceramics including carbonate-containing apatite, composites of hydroxyapatite and type I collagen, octa-containing phosphate and vaterite-type calcium carbonate doped with soluble silica (also discussed in Chapter 7).

PART EIGHT: BIOMIMETIC/BIOINSPIRED MATERIALS

Chapter 17 describes the current concepts of polymer-induced liquid precursors (PILPs), their application in bioinspired material synthesis and their relevance to bone and dentin regeneration. As defined and detailed by the authors, PILPs are one of the transient states in nonclassical crystallization, as noted by Gower et al. during the crystallization process of calcium

Bioceramics: From Macro to Nanoscale (continued)

carbonate in the presence of an acidic polypeptide. Relating to characterization studies and the macroscopic fluidity observed, the authors propose that these materials may be better described as "polymer-induced liquid-like precursors." PILPs can be used to manipulate crystal morphologies such as honeycomb patterns or inter-connected calcite structures. The application of the PILP process has been used to propose a novel model of a potential mechanism of bone formation regarding intrafibrillar mineralization of collagen. Another potential application is for remineralization of dental lesions.

PART NINE: RADIOTHERAPY APPLICATIONS

Chapter 18 is entitled "Electrospinning and nanofibrous structures for biomedical applications." This chapter informs us that artificial extracellular matrices (i.e., scaffolds) are important in tissue engineering constructs to guide cell behavior. Nanofibers and nanostructures can be fabricated using the electrospinning technique. This chapter described both conventional and advanced (i.e., emulsion, coaxial, and multiaxial) electrospinning techniques. A variety of natural and synthetic polymers used for electrospinning are described. There are a number of processing parameters, such as solvent selection and applied voltage, that affect fiber formation and structure. Electrospinning can be used to create multicomponent nanofibrous structure, functionalized nanofibers and ceramic nanoparticle-incorporated nanocomposite fibers. Several biomedical applications are described: skin substitute and wound dressing, controlled delivery of drugs and biomolecules, tissue engineering, chemical nanosensors or biosensors, filtration applications and others.

Bioceramics: From Macro to Nanoscale is a book that sets out to describe the diversity of approaches, materials, techniques and applications relating to using bioceramics to address tissue repair, regeneration and joint replacement. The international authorship contributes a broad perspective to these topics. Individual chapters can easily be used in biomaterials classes for review of specific topics. The book is easy to read, and the figures, tables and references add to the educational value. There are several topics such as robocasting and PILPs that will appeal to the more senior students and those with existing expertise in bioceramics.

If using this book as a textbook, a supplemental source regarding the composition, structure, biology and mechanical properties of those tissues being augmented, treated or regenerated by bioceramics is necessary. For example, since biological resorption and bone stimulating activity of bioceramics are tightly linked to the chemistry and physical structure of the bioceramic, a deeper, more thorough analysis of the cellular response than contained herein is necessary to tease apart the nuances of bioactivity. A more definitive acknowledgement of the differences between natural bone mineral structure from hydroxyapatite would further help the field progress forward in design of new bioceramics that can be degraded by osteoclast activity designed for resorbing poorly crystalline, nanocrystalline carbonated apatite.

OVERALL, THIS COMPREHENSIVE BOOK ON BIOCERAMICS MAKES A STRONG ADDITION TO A BIOMATERIALS SCIENTIST'S PERSONAL LIBRARY AND IS HIGHLY RECOMMENDED.

Suggestion of articles as supplemental reading include:

- Plazanet M, Tasseva J, Bartolini P, Taschin A, Torre R, Combes C, Rey C, Di Michele A, Verezhak M, Gourrier A. Time-domain THz spectroscopy of the characteristics of hydroxyapatite provides a signature of heating in bone tissue. *PLoS One*. 2018;13(8):e0201745.
- ASTM F3106 – 14. Standard Guide for in vitro Osteoblast Differentiation Assays.

Overall, this comprehensive book on bioceramics makes a strong addition to a biomaterials scientist's personal library and is highly recommended. It fills a void in the literature and the authors are to be commended for this extensive, updated resource on bioceramics.

Plans for the 2022 Annual Meeting in Baltimore, MD

AND EVERYTHING ELSE THE CITY HAS TO OFFER

By Carl Simon and Cherie Stabler

Planning for next year's Annual Meeting in Baltimore, Maryland is well under way. The meeting will take place April 27-30 2022, and the theme is "the perilous fight to translate innovative research to commercial viability." You might recognize the phrasing which borrows from the US national anthem. The Star-Spangled Banner was penned in Baltimore Harbor in 1814 by Francis Scott Key as he observed the British Royal Navy bombarding Fort McHenry during the War of 1812 (about a mile from the venue). The program is focused on ideas that involve breakthroughs in biomaterials science, translation of basic research to clinical application, next-generation medical devices, and content that explores standards development, regulatory issues, and commercial realities. We're intentionally capitalizing on our proximity to Washington, DC to engage the standards and regulatory communities in dialogue on many fronts, and we hope to address several of the hurdles to commercialization with practical solutions.

The meeting will consist of 74 sessions including six premeeting workshops, four plenary sessions, eight panels and 56 symposia and general sessions. The 12-member organizing committee includes past Chairs Bill Murphy (U. Wisconsin) and SuPing Lyu (Medtronic); future chairs Jennifer Woodell-May (Zimmer) and Karen Christman (UCSD); SIG Chair Representative Ashley Carson Brown (UNC); Society For Biomaterials President Guigen Zhang (U. Kentucky); DEI Representative Ana Maria Porras (U. Florida); as well as LaShan Simpson (Mississippi State U.); Michael Francis (Embody); and Jamal Lewis (UC Davis). The Committee is chaired by Carl Simon (NIST) and Cherie Stabler (U. Florida). The four plenary sessions will be the Welcoming Ceremony to open the meeting, the Acta Biomaterialia Awards, the Society Awards and the Clemson Awards.

The meeting will be held in Baltimore Marriott Waterfront and the Bash on Friday night will be at the Maryland Science Center. Several SIG events will be held at Power Plant Live, which is a lively outdoor and indoor entertainment area with restaurants, concert spaces and nightclubs. There will be young investigator engagement opportunities, a scavenger hunt, sessions on biomaterials education and events focused on diversity, equity and inclusion. Industry focused content makes up a sizable portion of the program focusing on manufacturing, sterilization, commercialization, assessment and entrepreneurship.

Other local attractions include the Inner Harbor area, USS Constellation (US Navy ship built in 1853), National Aquarium, Reginald Lewis Museum and American Visionary Art Museum. We are excited to return to an in-person meeting, and we hope that you will join us in Baltimore to reconnect with friends and colleagues, discuss biomaterials science, meet interesting people and learn about new developments in our field.

Contacts: Carl Simon, carl.simon@nist.gov; Cherie Stabler, cstabler@bme.ufl.edu

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

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

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

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