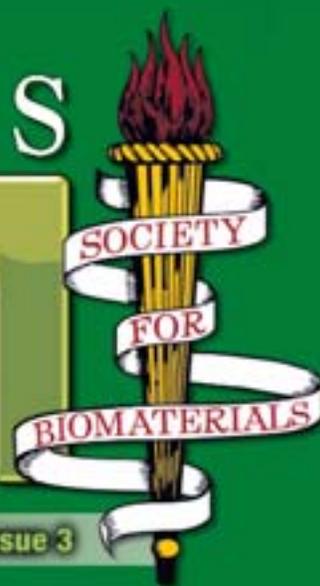


# BIOMATERIALS FORUM



Third Quarter 2005 • Volume 27, Issue 3

**Student Chapter Update**

**Memphis Establishes  
Biomaterials Day**

**Translational  
Research  
Awards  
Presented**



*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 (e-mail: [info@biomaterials.org](mailto:info@biomaterials.org)) or visit the Society's Web site, [www.biomaterials.org](http://www.biomaterials.org).

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

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

Address corrections should be sent to *Biomaterials Forum*, 15000 Commerce Parkway, Mt. Laurel, NJ 08054.

Requests for advertising information should be directed to Frank Scussa at [fscussa@ahint.com](mailto:fscussa@ahint.com) or (856) 439-0500, ext. 4427. Information is also available on the Society's Web site, [www.biomaterials.org](http://www.biomaterials.org).

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

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

Copyright© 2005 ISSN 1527-6031  
Society For Biomaterials  
All rights reserved

# BIOMATERIALS FORUM



The official news magazine of the **SOCIETY FOR BIOMATERIALS** • Volume 27, Issue 3

## Executive Editor

Martine LaBerge, Clemson University  
501 Rhodes Research Center, Clemson, SC 29634-0905  
Phone: (864) 656-5557 • Fax: (864) 656-4466  
E-mail: [martine.laberge@ces.clemson.edu](mailto:martine.laberge@ces.clemson.edu)

## Managing Editor

Frank Scussa, Society For Biomaterials  
15000 Commerce Parkway, Mt. Laurel, NJ 08054  
Phone: (856) 439-0500 • Fax: (856) 439-0525  
E-mail: [fscussa@ahint.com](mailto:fscussa@ahint.com)

## Government News Contributing Editor

Joy Dunkers, National Institute of Standards and Technology  
100 Bureau Dr., Stop 8541, Gaithersburg, MD 20899-8541  
Phone: (301) 975-6841 • Fax: (301) 963-9143  
E-mail: [joy.dunkers@nist.gov](mailto:joy.dunkers@nist.gov)

## Government News Contributing Co-Editor

Christine A. Kelley, National Heart, Lung and Blood Institute  
National Institutes of Health  
6701 Rockledge Dr., Suite 9180, Bethesda, MD 20892-7940  
Phone: (301) 435-0513 • Fax: (301) 480-1336  
E-mail: [ck53r@nih.gov](mailto:ck53r@nih.gov)

## Industrial News Contributing Editor

Steve T. Lin, Exactech Inc.  
2320 NW 66th Court, Gainesville, FL 32653  
Phone: (352) 377-1140 • Fax: (352) 378-2617  
E-mail: [steve.lin@exac.com](mailto:steve.lin@exac.com)

## Society Business & Membership News Contributing Editor

Antonios G. Mikos, Rice University  
MS 142, PO Box 1892, Houston, TX 77251  
Phone: (713) 348-5355 • Fax: (713) 348-4244  
E-mail: [mikos@rice.edu](mailto:mikos@rice.edu)

## Special Interest Group News Contributing Editor

Elaine Duncan, Paladin Medical Inc.  
PO Box 560, Stillwater, MN 55082-0560  
Phone: (715) 549-6035 • Fax: (715) 549-5380  
E-mail: [duncan@paladinmedical.com](mailto:duncan@paladinmedical.com)

## University and Research Institution News Contributing Editor

Dave Puleo, University of Kentucky  
Center for Biomedical Engineering  
205 Wenner-Gren Lab, Lexington, KY 40506-0070  
Phone: (859) 257-2405 • Fax: (859) 257-1856  
E-mail: [puleo@uky.edu](mailto:puleo@uky.edu)

## Book Review

Liisa Kuhn, University of Connecticut Health Center  
Center for Biomaterials  
263 Farmington Avenue, Farmington, CT 06030-1715  
Phone: (860) 679-3922 • Fax: (860) 679-4889  
E-mail: [Lkuhn@uchc.edu](mailto:Lkuhn@uchc.edu)

## Special Interest Group Reporters

**Biomaterials Availability & Policy**  
**Biomaterials-Cell/Organ Therapies**  
**Biomaterials Education**  
**Cardiovascular Biomaterials**  
**Dental/Craniofacial Biomaterials**

Karen Masterson, [karen.masterson@thoratec.com](mailto:karen.masterson@thoratec.com)  
Judy Ulreich, [ulreich@u.arizona.edu](mailto:ulreich@u.arizona.edu)  
Jeffrey Karp, [Jeffrey\\_m\\_karp18@hotmail.com](mailto:Jeffrey_m_karp18@hotmail.com)  
Daniel L. Mooradian, [d.mooradian@biovascular.com](mailto:d.mooradian@biovascular.com)  
TBA

**Drug Delivery**  
**Implant Pathology**  
**Ophthalmologic Biomaterials**  
**Orthopedic Biomaterials**

James Marotta, [james.marotta@smith-nephew.com](mailto:james.marotta@smith-nephew.com)  
Michelle Tucci, [mtucci@orthopedics.umsmc.edu](mailto:mtucci@orthopedics.umsmc.edu)  
Mutlu Karakelle, [mutlu.karakelle@alconlabs.com](mailto:mutlu.karakelle@alconlabs.com)  
TBA

**Proteins & Cells at Interfaces**  
**Surface Characterization & Modification**  
**Tissue Engineered Products**

David Castner, [castner@nb.engr.washington.edu](mailto:castner@nb.engr.washington.edu)  
Karen Burg, [kburg@clemson.edu](mailto:kburg@clemson.edu)  
Sarina Kay, [latinasarina@rocketmail.com](mailto:latinasarina@rocketmail.com)



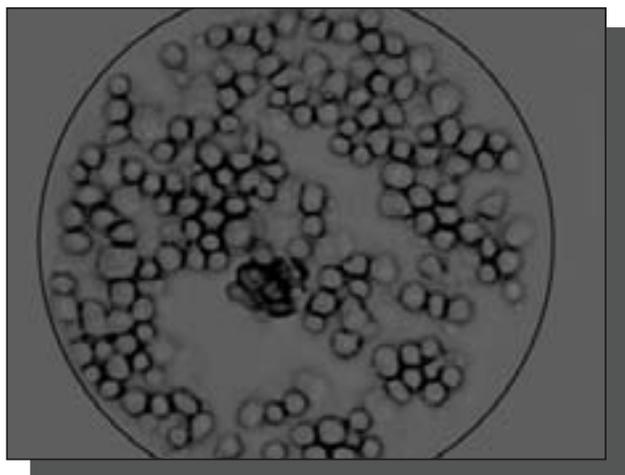
## Features

### 10 **Direct Writing of Biomaterials: A Paradigm Shift in Tissue Engineering**

While tissue engineering includes biomaterials, cells, biomolecules, informatics, and engineering, the fundamental building block of tissue engineering is the living cell. Cells are generally implanted or seeded into a scaffold material to enhance structural properties, deliver biochemical factors including vital cell nutrients, and to exert mechanical and biological influences. There are shortcomings to this approach, including random cell attachment, meaning all evolved tissue structure is lost and vascularization is needed if the construct is greater than 1 mm in thickness. Rarely though has tissue engineering been considered from a more strict engineering perspective. The authors foresee the possibility to expand upon traditional tissue engineering. That is, instead of addressing medical problems by using living cells to engineer new biomaterials, use engineering principles to manipulate biomaterials (including cells) in a well-controlled manner.

### 12 **Early Career Translational Research Awards Presented**

The Early Career Translational Research Awards in Biomedical Engineering, supported by the Wallace H. Coulter Foundation, are designed to support biomedical engineering research that is translational in nature, and to encourage and assist eligible biomedical engineering investigators as they establish themselves in academic research careers with two years of funding. See the 2005 recipient members of the Society.



MAPLE DW transfer of MG-63 human osteoblast cells. From "Direct Writing of Biomaterials: A Paradigm Shift in Tissue Engineering," by D.B. Chrisey, A. Doraiswamy, and R.J. Narayan.

## Departments

### The Torch

- 2 From the Editor
- 3 From the President
- 4 Update from Headquarters
- 5 Lemons Receives William T. Cavanaugh Award
- 5 Agrawal Appointed Interim Dean at University of Texas at San Antonio
- 6 Webster Named Editor-in-Chief of the International Journal of Nanomedicine
- 6 Memphis Establishes Biomaterials Day

### Chapter News

- 7 SFB National Student Chapter Update

### Book Review

- 8 Tissue and Organ Regeneration in Adults

### Industry News

- 13 BioInk

### Biomaterials Community

- 16 Community Calendar

## From the Editor

### Translational Biomaterials Research: A New Academic Paradigm



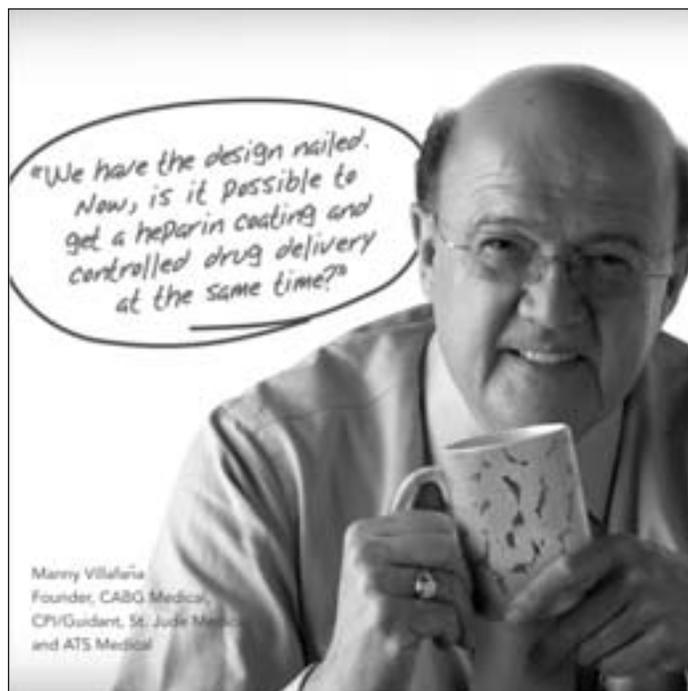
The academic world either in medicine, engineering, or science is driven by the intrinsic desire of its faculty members to succeed. Success is normally recognized by publications, national awards, and funding, without neglecting teaching effectiveness! More recently, in biomedical engineering, academic success has also encompassed the translation of

research findings and products made in fundamental laboratories into testable hypotheses for clinical trials. The intent of translational research is to translate knowledge derived from laboratory work or basic research into clinical applications where diagnostic or therapeutic interventions can be applied to the treatment or prevention of diseases. It is research that brings discovery directly from the bench to practical applications in patients.

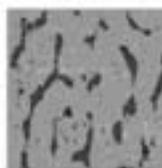
Current translational research is built on the foundations of fundamental basic research leading to ideas, insights, and discoveries. As such, one would argue that translational research in biomaterials science and engineering has been conducted since the inception of this field. However, even though biomaterials researchers have been translational researchers for many years, the road to success has not been without hurdles.

NIH has been applauded for openly recognizing translational research in its road map and funding numerous Bioengineering Research Partnerships (BRPs) focusing on translational multidisciplinary research as an example. In 2004, the Wallace H. Coulter Foundation established two main programs to financially support translational research in biomedical engineering: Translational Research Partnerships in Biomedical Engineering, and Early Career Translational Research Awards in Biomedical Engineering, which clearly emphasize the role of biomedical engineers in translational research. This issue of *Biomaterials Forum* recognizes the Wallace H. Coulter Foundation for its positive impact on the field of biomaterials innovation for patient care by featuring the first Early Career Translational Research Awardees who are members of the Society For Biomaterials. According to NIH, "translational research has proven to be a powerful process that drives the clinical research engine."

The above programs catalyze the needed research infrastructure to strengthen and accelerate outcomes, and clearly establish translational research in bioengineering as a new academic paradigm.



Manny Villafra  
Founder, CABG Medical,  
CPVGuidant, St. Jude Medical,  
and ATS Medical



Atomic Force  
Microscopic image,  
Bravo™ drug  
delivery matrix.

The answer is a resounding "yes" ... with a unique combination of Applause™ heparin coating and Bravo™ drug delivery matrix.

Working with SurModics, a leader in surface modification and drug delivery technologies, CABG Medical is realizing its vision of advancing conventional bypass surgery and improving outcomes for coronary bypass patients. Go to [www.surmodics.com/cabg](http://www.surmodics.com/cabg) for the full story.

For more than 20 years, SurModics has teamed with the world's leading life sciences companies to help reliably solve their paramount product development challenges.

So, what's your question?

To see how you and SurModics can bring innovation together, call 866-SURMODX or visit [www.surmodics.com](http://www.surmodics.com).



Bravo and Applause are trademarks of SurModics, Inc. All rights reserved. ©2005 SurModics, Inc.

## SIGs 'R Us



In Memphis, I attended my first all-SIGs meeting. I came away impressed with the enthusiasm of the many volunteers who make Special Interest Groups (SIGs) one of our core assets. There are many other scientific groups who would be jealous of the dedication of these individuals who represent the base of our Society. Perhaps that's why there are so many other organizations

ranging from TMS to the Tissue Engineering Society who want to work with SFB.

I have also learned that there are concerns about the quality of our meetings. There is no doubt that we are presenting the best there is in materials used in medicine and dentistry. We had, in Memphis, a huge turnout of abstracts in a nanotechnology symposium, for example. On the other hand, the bio part might have been a little sketchy in places and many of the leaders in biomaterials chose not to come to Memphis. I also heard that some industrial non-biomaterial potential participants don't see SFB as the place to go to learn about the frontiers of biomaterial applications.

So is our strength also our weakness? We have terrific member involvement through the SIGs (or on their own initiative) in planning the program. As I am writing this in early June, John Kao (chair of the 2006 meeting) is collecting lots of terrific suggestions for symposia and workshops. This is as it is supposed

to be and will enable John and his committee to build a great meeting from the ground up. But some of the suggestions, while good, are not great and certainly will not, without tweaking, meet the strategic objectives of the Society. But if we improve on these suggestions, do we run the risk of offending some of our volunteers, either symposia organizers or suggested invited speakers? A 'ground up' system is great, but then how does SFB exert quality control? How does SFB protect its brand? (I will write about branding in a future article.)

You have probably figured out that there is a deeper question. It isn't organizing the program for the Pittsburgh meeting that raises the issue—everyone understands that the symposium proposals are just that and all symposium proponents will be delighted to receive suggestions for a better symposium—but rather the variable nature and mandate of the SIGs. Some SIGs are exquisitely healthy and strong while others are not. Some are aligned well with the goals of the Society and some are not. So the overall question is, how do we make better use of the SIGs? How do we make them and fund them better? What do we really expect them to do and how do we give them the tools to get it done?

These questions and others are being addressed by Andres Garcia, the SIG representative on Council, and Elaine Duncan, the past SIG representative, who I have asked to think through these questions and suggest a number of ways in which we can move forward with the SIGs. If you have any suggestions, please contact either of them.

### 2005/2006 SIG Officers

#### *Biomaterials Availability & Policy*

Chair - Carl R. McMillin, PhD  
Vice-Chair - Phil Triolo, PhD  
Secretary/Treasurer - Elaine Duncan, MSME, RAC  
Program Chair - Curtis B. Herbert

#### *Biomaterials Cell Organ Therapies*

Chair - Laura J. Suggs, PhD  
Vice-Chair - Karen J.L. Burg, PhD  
Secretary/Treasurer - Krishnendu Roy, PhD  
Program Chair - Brenda Mann, PhD

#### *Biomaterials Education*

Chair - Jeffrey M. Karp, PhD  
Vice-Chair - Elizabeth A. Friis, PhD  
Secretary/Treasurer - Lisa Benson, PhD  
Program Chair - Abhay Pandit, PhD, MPH

#### *Cardiovascular Biomaterials*

Chair - Narendra R. Vyavahare, PhD  
Vice-Chair - Michael S. Sacks, PhD  
Secretary/Treasurer - Julie Trudel, PhD  
Program Chair - Christopher W. Widenhouse, PhD

#### *Dental/Craniofacial Biomaterials*

Chair - John L. Ricci, PhD  
Vice-Chair - Spiro J. Megremis, PhD  
Secretary/Treasurer - John E. Kemnitzer, PhD  
Program Chair - Joel D. Bumgardner, PhD

#### *Drug Delivery*

Chair - Mark E. Byrne, PhD  
Vice-Chair - Liisa T. Kuhn, PhD  
Secretary/Treasurer - Esmail Jabbari, PhD  
Program Chair - Jeffrey I. Joseph, DO

#### *Implant Pathology*

Chair - Thomas Bauer, MD, PhD  
Vice-Chair - Michelle A. Tucci, PhD  
Secretary/Treasurer - Jon P. Moseley  
Program Chair - Carmelita G. Frondoza, PhD

#### *Ophthalmological Biomaterials*

Chair - Adrian Raiche, PhD  
Vice-Chair - Idan Avihar  
Secretary/Treasurer - Richard A. Gemeinhart, PhD  
Program Chair - Daniel J. Urbaniak, PhD

#### *Orthopaedic Biomaterials*

Chair - Michele S. Marcolongo  
Vice-Chair - Yen-Shuo Liao, PhD  
Program Chair - Elaine Duncan, MSME, RAC  
Program Chair - Lakshmi Nair, PhD

#### *Proteins and Cells at Interfaces*

Chair - Thomas Webster, PhD  
Vice-Chair - Christopher A. Siedlecki, PhD  
Secretary/Treasurer - Julie Stenken, PhD  
Program Chair - Thomas Webster, PhD

#### *Surface Characterization & Modification*

Chair - Erika Johnston  
Vice-Chair - Lara J. Gamble, PhD  
Secretary/Treasurer - Jeffrey L. Schwartz  
Program Chair - Lakshmi Nair, PhD

#### *Tissue Engineering*

Chair - Rui L. Reis  
Vice-Chair - Ken Webb, PhD  
Secretary/Treasurer - Esmail Jabbari, PhD  
Program Chair - Ahmed El-Ghannam, PhD

*We are grateful for their time and commitment to the Society For Biomaterials!*

# Staff Updates from Headquarters

**The Torch**

By Dan Lemyre,  
Assistant Executive Director

Things have been very busy at SFB headquarters. In addition to planning for the Annual Meeting—which was a huge success—we have been finalizing the first SFB audit of the financial statements, orienting the new Executive Director, Victoria Elliott, and training the temporary membership coordinator, Rebecca Riedesel, to move into a permanent position! This quarter, we bring you highlights from the 30th Annual Meeting and Exposition, and committee updates. The SFB staff also welcomes Dr. Michael Sefton, the Society's President for 2005-06. We look forward to a productive and fulfilling year.

## **Awards Ceremonies and Nominations Committee**

The 2005-06 committee will be chaired by Nicholas Peppas, SFB 2nd Past President. Committee members include Julia Babensee, Joel Bumgardner, Karen Burg, and Jack Parr.

## **Bylaws Committee**

Attendees of the Annual Business Meeting held during the 30th Annual Meeting in Memphis approved the proposed bylaws amendment to require that SFB journal editors be elected by the Council of the Society as representatives of the Society. The updated bylaws may be viewed on the SFB Web site.

## **Education & Professional Development Committee**

In addition to ongoing requests for meeting endorsements from other societies, the Education and Professional Development Committee is also on the road toward offering a surgical video library on the Society's Web site! In the year ahead the committee also plans to take a more active role in advancing the objectives of SFB's Student Chapters.

## **Finance Committee**

The SFB Council approved the newly proposed investment policy, and with just a couple adjustments, the long-term policy will also be approved. The Finance Committee is now embarking on a review of proposals for an investment planner so we can find one with the right skills to assist SFB in making the most of its investments.

## **Long Range Planning Committee**

Included in the 2005 budget is a strategic planning initiative that will help ensure the Society's continued success while advancing the Society's mission to provide the leading forum to disseminate knowledge of biomaterials among researchers, educators, and developers of materials and biomedical device technology.

## **Meeting Committee**

Congratulations to Dr. Joel Bumgardner and the entire 30th Annual Program Committee on a successful meeting! Over 1,300 professionals attended the meeting, which included over 50 exhibitors and offered four full days of excellent programming. Welcome, too, to John Kao, chair of the 31st Annual Meeting scheduled for April 26-29, 2006, in Pittsburgh, Pa.

## **Membership Committee**

A new membership application is now available on the SFB Web site, [www.biomaterials.org](http://www.biomaterials.org). The 2005-06 Membership Committee will be chaired by Margaret Kayo. Committee members elected at the Annual Business Meeting include Barbara Blum, Lynne Jones, Liisa Kuhn, and William Reichert. This new committee is already hard at work reviewing applications and exploring opportunities for new SFB membership benefits!

## **Publications Committee**

The Publications Committee has been accepting proposals for new editors of the *Biomaterials Forum* and the SFB Web site.

## **SFB Staff**

New Executive Director hired! Victoria Elliott was formally introduced to the membership in Memphis. Elliott, a registered pharmacist, joined Association Headquarters as the SFB Executive Director on April 25, 2005. She comes to SFB with more than eight years of association management experience, all of it spent with the Pennsylvania Society of Health-System Pharmacists. In her short time with SFB Elliott has worked with President Sefton and SFB staff to develop an action plan covering a number of organizational priorities. Stay tuned for updates in the coming issues of the *Forum*.

*Executive Director*

**Victoria E. Elliott, RPh, MBA, CAE**  
[velliott@biomaterials.org](mailto:velliott@biomaterials.org)

*Assistant Executive Director*

**Daniel Lemyre**  
[dlemyre@biomaterials.org](mailto:dlemyre@biomaterials.org)

*Membership Coordinator/Administrative Assistant*

**Becky Riedesel**  
[rriedesel@ahint.com](mailto:rriedesel@ahint.com)

*Senior Meeting Manager*

**Anthony Celenza**  
[acelenza@biomaterials.org](mailto:acelenza@biomaterials.org)

*Managing Editor, Biomaterials Forum*

**Frank Scussa**  
[fscussa@biomaterials.org](mailto:fscussa@biomaterials.org)

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

Society For Biomaterials  
15000 Commerce Parkway  
Suite C  
Mount Laurel, NJ 08054  
Phone: 856-439-0826  
Fax: 856-439-0525  
E-mail: [info@biomaterials.org](mailto:info@biomaterials.org)  
URL: [www.biomaterials.org](http://www.biomaterials.org)

# Lemons Given 2005 William T. Cavanaugh Memorial Award



Jack E. Lemons, professor at the University of Alabama in Birmingham and Past-President of the Society For Biomaterials, has been named the 2005 recipient of the ASTM International W. T. Cavanaugh Memorial Award. He was also made an honorary member of the organization for his "outstanding and distinguished leadership in promoting national and international standards for medical/surgical implants and materials."

Dr. Lemons is a long-time leader of Committee F04 on Medical and Surgical Materials and Devices.

The W. T. Cavanaugh Memorial Award was established in 1987 in memory of the late William T. Cavanaugh, ASTM chief executive officer from 1970 until his death in 1985. The award is given to a person or persons of widely recognized eminence in the voluntary standards system.

# Agrawal Appointed Interim Dean of Engineering at University of Texas at San Antonio

Society For Biomaterials President-Elect Mauli Agrawal has been appointed Interim Dean of Engineering at the University of Texas at San Antonio. He assumed his new role August 1, 2005.

Mauli has served as the Director of the Institute for Bioengineering and Translational Research and the Peter Flawn Professor of Biomedical Engineering at the University of Texas at San Antonio. He also served as the Associate Dean for Graduate Studies and Research. In 1997 he co-founded Xilas Medical, which is a medical device company now selling FDA-approved products.

An active member of the Society For Biomaterials since 1991, Mauli has been an ardent volunteer and has served the Society in various capacities, including: Secretary/Treasurer and Secretary/Treasurer Elect (2001-2005); Program Chair, Annual Meeting at St. Paul/Minneapolis (2001); Program Committee (1999-2003); Member-at-Large on Board of Directors (1999-2000); Assistant Program Chair, Annual Meeting at Providence

(1999); Chair, Orthopaedic Biomaterials SIG (1988-1999); Chair, Membership Committee (1997-1999); Member, Council (1997-1999); Member, Long Range Planning Committee (1997-1998); Member, Committee for Education and Professional Development (1996-1997); Member, Sub-committee on Member Status Development (1993-1995).

He also served as a Contributing Editor for the *Biomaterials Forum* from 1993 to 2000 and currently serves on the Editorial Boards of both the *Journal of Biomedical Materials Research* and the *Journal of Biomedical Materials Research (Applied Biomaterials)*. During his term as Secretary/Treasurer, he oversaw the financial aspects of the transition between management companies handling Society business. Earlier, he was instrumental in the establishment of a Young Investigator Award (effective 1999) for the Society. As Member-at-Large, he was responsible for developing a policy for handling grievances registered by the membership and for establishing the concept of a Biomaterials Day.

# Webster Named Editor-in-Chief of the International Journal of Nanomedicine



Dove Medical Press has named Thomas J. Webster, member of the Society For Biomaterials, Editor-in-Chief of their new *International Journal of Nanomedicine*. The *International Journal of Nanomedicine* is an international, peer-reviewed journal focusing on the application of nanotechnology in diagnostics, therapeutics, and drug delivery systems throughout the biomedical field.

Reflecting the growing activity in this emerging specialty, the aim of this journal is to highlight research and development in the nanosciences, leading to potential clinical applications in the prevention and treatment

of disease. A number of additional members of the Society For Biomaterials have joined Tom in serving on the editorial board. More details on the journal can be found at [www.dovepress.com/IJN.htm](http://www.dovepress.com/IJN.htm).

Tom is an Associate Professor of the Weldon School of Biomedical Engineering at Purdue University. His research is in the design, synthesis, and application of nanophase materials in various medical applications. Nanophase materials are those materials with at least one dimension less than 100 nm. He hopes the journal will educate learners on the many benefits nanotechnology can make to medicine. He has been active in the Proteins and Cells at Interfaces, and Biomaterials Education, Special Interest Groups.

# Memphis Establishes Biomaterials Day

In recognition of the significant role the biomaterials industry plays in and around the Memphis area, Shelby County officials declared a special Biomaterials Day in April to coincide with the Society For Biomaterials recent 30th Annual Meeting, which was held in Memphis April 27-30, 2005.

The Mayor of Shelby County, AC Wharton, Jr., presented the Society with a proclamation naming April 27, 2005, as Biomaterials Day. The proclamation urged citizens in the area to express their appreciation for the people and technologies in the field of biosciences and their impact on the entire community. According to Shelby officials, Memphis has a rich history and tradition of achievement within the biosciences, led by its academic, medical, and business communities. The Memphis area is the second largest producer of orthopedic medical devices in the United States.



*Greetings from the SFB National Student Chapter! This article is appearing in Biomaterials Forum to highlight our student chapters and student members' accomplishments throughout the year. In addition, information pertaining to the upcoming SFB Annual Meeting in Pittsburgh will be posted in the future, as well as fun tidbits for graduate students. At our Memphis meeting the following chapters were recognized by the National Chapter for their outstanding work.*

### **Outstanding Community Outreach**

*University of Washington*

University of Washington chapter students were able to visit local K-12 schools and introduce students to biomaterials and tissue engineering. Graduate students volunteered their time to give presentations combined with hands-on design projects to students and teachers interested in biomaterials, bioengineering, and general science. Two projects that the kids were involved in were designing a prosthetic finger and designing a surface that can recognize a simulated cell surface. From May 2004 to April 2005 the chapter members visited 26 schools and over 1,900 students!

### **Outstanding Fundraising and Industry Connections**

*University of Florida*

The University of Florida chapter participated in a number of activities with biotech companies. They hosted speakers from Ethicon Inc., Medtronic Xomed Inc., and Vistakon. In addition, members traveled to Georgia to participate in an industry tour of Kimberley-Clark's healthcare division and while in Memphis toured Medtronic Sofamor-Danek.

This chapter also did an amazing job fundraising. Through their Partners in Excellence fundraising efforts, departmental contributions, and funding secured through the Benton Engineering Council, the University of Florida chapter raised over \$8,400 this year.

### **Outstanding New Chapter**

*Michigan Tech*

Michigan Tech was recently recognized as a student chapter and they are off to a great start. Students began their year with a trip to Northwestern University to give undergraduate students a firsthand perspective of graduate life in biomaterials. The main outreach event for the chapter was called "Biomaterials Slime Time." Members went into the local elementary classrooms (6th-8th grade) to educate the students

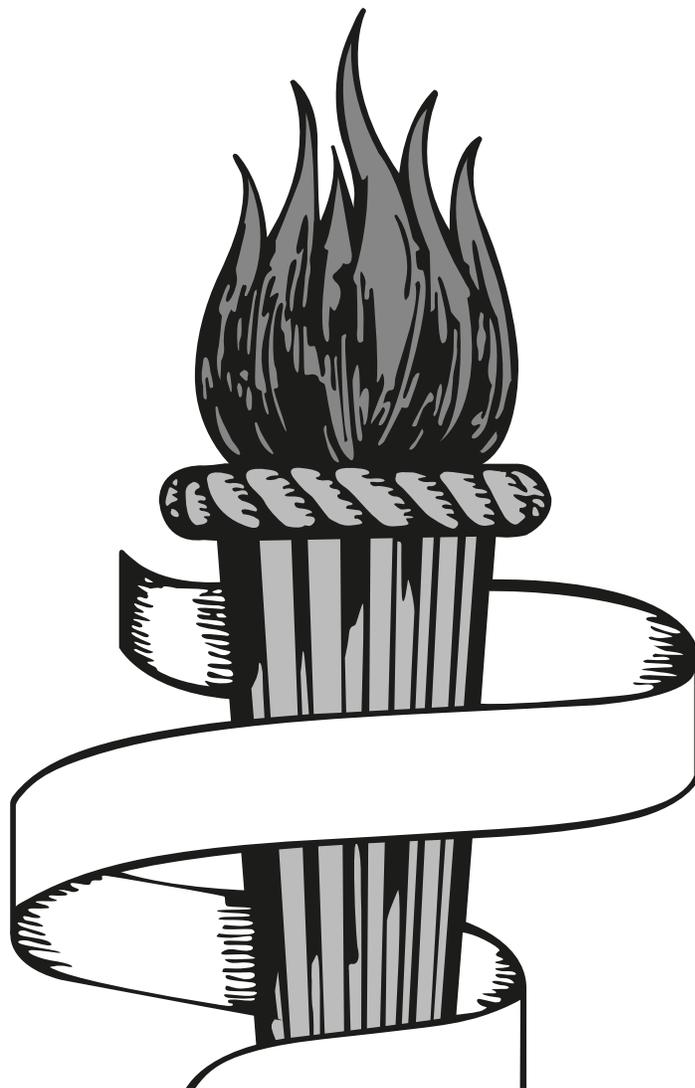
about biomedical engineering, and more specifically about biomaterials. Participants got to make slime using solutions of borax, glue, and food coloring, which was used to demonstrate viscoelastic properties and how this relates to the body. Other activities included making Christmas cookies to be delivered to the elderly and organizing a "blue-screen" photo booth for the Michigan Tech's annual Winter Carnival All-Nighter as a fundraiser and to attract new members.

### **Annual Travel Award**

1st place: Clemson University - Clemson brought 42 students to Memphis and traveled a total of 24,150 miles.

2nd place: University of Washington

3rd place: University of Florida



# Tissue and Organ Regeneration in Adults

Book Review

By Liisa Kuhn

By Ioannis V. Yannas. Springer-Verlag, New York. 2001.

While it is well known that adults, whether animal or human, do not spontaneously regenerate any of their organs that have been lost to accidental trauma or surgery, the field of tissue engineering offers a means to reverse this long-held belief. The synthesis of tissues and organs in adults through the use, or combined use, of extracellular matrix analogs, cytokines, and cells is now a clinically available reality. How do they work? Are there trans-organ rules that apply to all tissues and organs? Dr. Yannas has put the subject of tissue regeneration in the context of general wound healing in a clear and understandable manner. From this, he concludes that yes, there are generic methodologies for all tissue regeneration. The main aspects of wound healing that must be overcome, in order to get regeneration, are contraction and scar formation. Dr. Yannas demonstrates through extensive literature review that this has been done through the use of non-diffusible extracellular matrix analogs that act as regulators to arrest contraction, and to contain and maintain a vital population of regenerative cells and cytokines.

The volume is divided into four major sections. Loss of organ function, the basic medical problem treated in this volume, is defined in Chapter 1. The basic methodology of organ synthesis *in vivo* is described in Chapters 2 through 4. Application to adult skin and peripheral nerves is treated in detail in Chapters 5 through 7. Finally, detailed mechanistic hypotheses of induced tissue and organ regeneration are presented in Chapters 8 through 10, leading to generic methodology for organ regeneration. This book is still one of the only, if not the only, single-author textbooks on organ synthesis, and as such provides a much-needed, integrated, unifying treatise on the subject.

A nice feature of the book is the author's approach of providing a thorough summary of the empirical results of regenerative activities observed in both skin and nerve experiments, and then following this with a discussion of proposed common mechanisms. For example, there is a table summarizing the relative regenerative activity of growth factors, cells and scaffolds that have been used in the regeneration of skin (Table 5.3). It is separated into growth factors, pharmacological reactants, keratinocyte sheets, cell-free regeneration templates, and cell-seeded regeneration templates. For each of these categories, the animal model and the final configuration of the repaired tissue, whether contraction, scar, or regeneration is presented. Hence, at a glance, one can readily see which configurations led to skin regeneration and which particular growth factors or cytokines led to enhancement of scarring, even in fetal models. There also is a table summarizing several tubulated configurations for the regeneration of a peripheral nerve (Table 6.1), again leading to ready assessment of which configurations were most regenerative. This volume also includes an excellent discussion of critical size-defect animal models, which are required to truly assess regeneration. It was also interesting to read developmental biology tidbits about which animals can regenerate which limbs at which stage of development. I had also not realized that our own livers do not regenerate when a portion is surgically removed or damaged; the remaining

segments just get larger to retain function (compensatory growth).

In summary, this textbook summarizes an extensive set of data on induced regeneration in skin and nerve, concluding with suggestions for generic methodologies for synthesis of other organs. It is well written, with high-quality diagrams and micrographs. It is appropriate for biologists, experimental surgeons, and biomedical engineers at the graduate level and above. As a professor who teaches tissue engineering, I now have an excellent summary of skin and nerve regeneration modalities, and their shortcomings and strengths to present to the students. While the emphasis of the book is on skin and nerve regeneration, I found that even a hard-tissue biomaterials scientist like myself could take away several useful biological and trans-organ regeneration concepts: mainly the important role of the extracellular matrix analog (or non-diffusible regulator) within the framework of wound healing.

## Contents

### 1. The Irreversibility of Injury

- 1.1. Repair versus Regeneration
- 1.2. Tissues and Organs
- 1.3. Spontaneous and Induced Regeneration
- 1.4. Diversity of Spontaneously Regenerative Phenomenon
- 1.5. Anatomical and Phylogenetic Focus of Regeneration
- 1.6. Wounds, Lesions and Defects
- 1.7. All Organs Can Be Irreversibly Injured
- 1.8. Critical Size of Defect versus Nature of Injured Tissue
- 1.9. A Universal End Product of Repair Processes in All Organs?
- 1.10. Theoretical Views of Adult Failure to Regenerate
- 1.11. The Missing Organ and How to Replace It
- 1.12. Synthesis of Tissues and Organs
- 1.13. Summary

### 2. Nonregenerative Tissues

- 2.1. The Experimental Volume: In Vitro or In Vivo?
- 2.2. Critical Presence of Exudate Inside the Defect
- 2.3. Certain Tissues in an Organ Regenerate Spontaneously
- 2.4. Other Tissues are Nonregenerative
- 2.5. Are Basement Membranes Regenerative?
- 2.6. Regenerative Similarity of Tissues in Different Organs
- 2.7. The Tissue Triad
- 2.8. Summary

### 3. Anatomically Well-defined Defects

- 3.1. Spatial Parameters of an Experiment in Induced Regeneration
- 3.2. Generation of the Experimental Volume
- 3.3. Deletion of Nonregenerative Tissues
- 3.4. Anatomical Boundaries
- 3.5. Magnitude of Experimental Volume
- 3.6. Physical Containment
- 3.7. The Anatomically Well-defined Defect
- 3.8. Widely Used Animal Models
- 3.9. Summary

Continued on next page

## Book Review...

(Continued from page 8)

### 4. The Defect Closure Rule

- 4.1. Measuring the Outcome of a Regenerative Process
- 4.2. Mechanism of Healing versus Total Resulting Change
- 4.3. Initial and Final States of a Healing Process
- 4.4. Configuration of the Final State
- 4.5. Three Modes of Defect Closure in Organs
- 4.6. Defect Closure Rule
- 4.7. Relative Importance of the Three Modes of Defect Closure in Different Species
- 4.8. A Transition in Healing Behavior with Development
- 4.9. Summary

### 5. Regeneration of Skin

- 5.1. Parameters for Study of Healing Skin Defects
- 5.2. Synthesis of an Epidermis and a Basement Membrane
- 5.3. Synthesis of the Dermis
- 5.4. Partial Synthesis of Skin
- 5.5. Summary of Protocols
- 5.6. Simplest Conditions for Synthesis
- 5.7. Relative Regenerative Activity of Growth Factors, Cells and Scaffolds
- 5.8. Summary

### 6. Regeneration of a Peripheral Nerve

- 6.1. Parameters for the Study of Peripheral Nerve Regeneration
- 6.2. Synthesis of Myelinated Nerve Fibers
- 6.3. Synthesis of a Perineurium; the Epineurium
- 6.4. Synthesis of a Nerve Trunk
- 6.5. Regenerative Activity for Various Tubulated Configurations
- 6.6. Summary

### 7. Irreducible Processes for Synthesis of Skin and Peripheral Nerves

- 7.1. Reaction Diagrams
- 7.2. Irreducible Reaction Diagrams for Synthesis of Skin

### 7.3. *In Vitro* versus *In Vivo* Conditions

- 7.4. Conditions for Synthesis of Peripheral Nerves
- 7.5. A Fresh Look at the Tissue Triad
- 7.6. Toward Simple Protocols for Synthesis of the Entire Organ
- 7.7. Summary

### 8. The Antagonistic Relation Between Contraction and Regeneration

- 8.1. Contraction and Scar Formation versus Induced Regeneration
- 8.2. Nondiffusible Regulators as Probes of Contraction
- 8.3. Summary

### 9. Kinetics and Mechanism I: Spontaneous Healing

- 9.1. Mechanism versus Final State of Spontaneous Healing
- 9.2. Cell Phenotypes Exhibited During Spontaneous Healing
- 9.3. Go-Stop Signals for Skin Defect Closure in Adults
- 9.4. Skin Defect Closure in Fetal Models
- 9.5. Spontaneously Healing Defects in Peripheral Nerves
- 9.6. Summary

### 10. Kinetics and Mechanism II: Induced Regeneration

- 10.1. Induced Regeneration versus Spontaneous Healing
- 10.2. Kinetics of Skin Regeneration
- 10.3. Mechanism of Synthesis in the Dermis
- 10.4. Kinetics of Synthesis of Peripheral Nerves
- 10.5. Mechanism of Peripheral Nerve Regeneration
- 10.6. Similarities and Differences of Induced Regeneration in Skin and Nerves

Appendix: Method of Estimation of Critical Axon Elongation of an Arbitrary Tubulated Device Bridging Two Nerve Stumps

References  
Index

## CALL FOR NOMINATIONS

The Society For Biomaterials is soliciting nominations for the 2006 Awards listed below, and for the following Board of Directors positions:

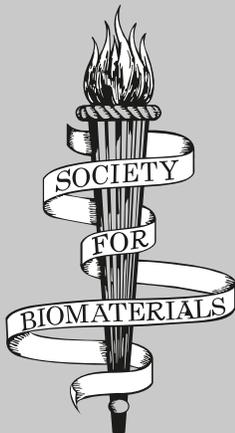
#### • President - Elect

#### • Member-At-Large

#### 2006 Awards:

- Founders Award
- C. William Hall Award
- Clemson Award for Applied Research
- Clemson Award for Basic Research
- Clemson Award for Contributions to Literature

- Technology Innovation and Development Award
- Young Investigator Award
- Student Award for Outstanding Research
- Outstanding Research by a Hospital Intern, Resident, or Clinical Fellow Award



To nominate a colleague, or yourself, for an award or position on the SFB Board of Directors, please visit the SFB Web site at: [www.biomaterials.org](http://www.biomaterials.org)

# Direct Writing of Biomaterials: A Paradigm Shift in Tissue Engineering

Feature

By D.B. Chrisey, A. Doraiswamy  
and R.J. Narayan

## Introduction

Tissue engineering<sup>1</sup> has always been a multidisciplinary field that encompasses biology, medicine, materials science and engineering.<sup>2</sup> The goal is to improve human health by maintaining, restoring, or improving tissue and organ function. While tissue engineering includes biomaterials, cells, biomolecules, informatics, and engineering, the fundamental building block of tissue engineering is the living cell. Cells are generally implanted or seeded into a scaffold material to enhance structural properties, deliver biochemical factors including vital cell nutrients, and to exert mechanical and biological influences. There are shortcomings to this approach, including random cell attachment, meaning all evolved tissue structure is lost and vascularization is needed if the construct is greater than 1 mm in thickness. Rarely though has tissue engineering been considered from a more strict engineering perspective.

We foresee the possibility to expand upon traditional tissue engineering. That is, instead of addressing medical problems by using living cells to engineer new biomaterials, use engineering principles to manipulate biomaterials (including cells) in a well-controlled manner.

Recently, researchers used a conventional ink jet printer to write patterns of biomaterials.<sup>3</sup> Termed "organ printing," their approach to write layered two-dimensional CAD/CAM (computer-aided design/computer aided manufacturing) patterns of biomaterials is one of several approaches to directly write biological systems.<sup>4</sup> Mironov et al. note that their work is a combination of engineering with developmental biology. This is a paradigm shift for tissue engineering as we are no longer growing tissues in a homogeneous and random fashion, but instead we are building tissues in some cases on the cell-by-cell level.

While the future impact of direct writing on the complex fabrication of vascularized three-dimensional tissue constructs for the long-term goal of organ construction is uncertain, it is clear that direct-write approaches offer a unique approach to study an array of novel biological systems.

## Direct Writing by MAPLE DW

At the Naval Research Laboratory, we have developed a novel laser forward-transfer process to direct write biological materials.<sup>5</sup> Termed MAPLE DW for matrix assisted pulsed laser evaporation direct write, this approach is shown schematically in Figure 1. In this process, a low fluence laser beam (typically an excimer laser) is focused on the backside of UV transparent quartz disk that is known as a ribbon. The novelty of the MAPLE DW transfer process is in the laser-material interaction at the interface where the absorbed laser energy gently propels cells toward a precise computer-designated location on the substrate. Each laser pulse transfers a voxel of cells and biopolymer (see Figure 2) and the motion of the computer-controlled stage holding the receiving substrate is synchronized to the firing of the laser. The ribbon in MAPLE is composed of a thick layer (about 10 microns) of extracellular

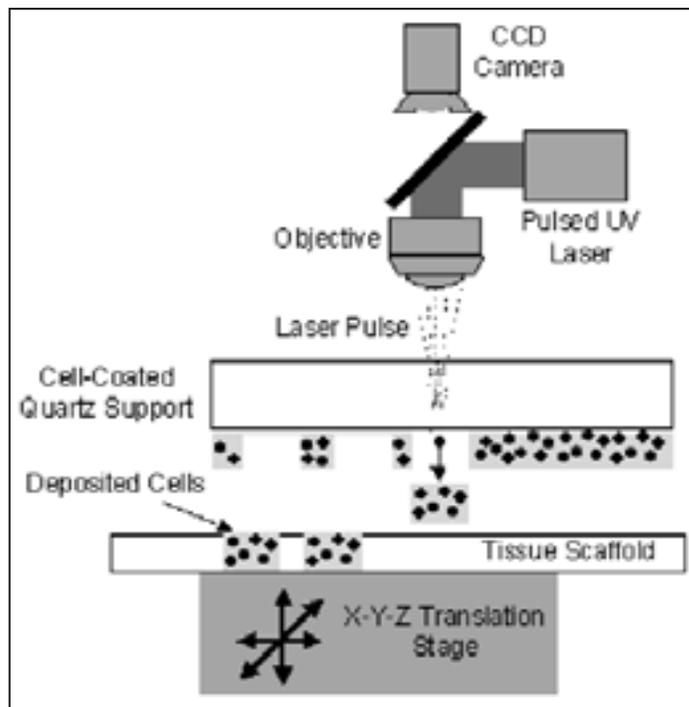


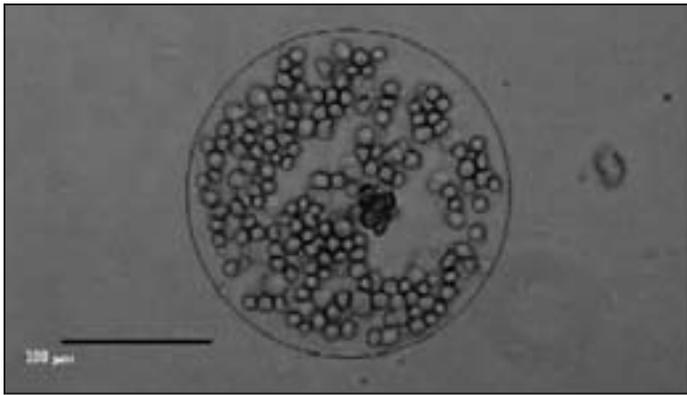
Figure 1. A schematic diagram of a MAPLE DW set up.

matrix<sup>6</sup> seeded with trypsinized cells. The receiving substrate has a similar thick layer of extracellular matrix and is used to reduce the deceleration of the desorbed cells.

To achieve CAM tissue construction using a CAD design at the cell-by-cell level, MAPLE DW must have several attributes. The technique must: be rapid and demonstrate computer-controlled placement of different materials at the 10 to 100 micron level; be able to deposit multiple cell types; be able to deposit molecules like growth factors, recruitment factors, and differentiation chemicals; be amenable to novel scaffolding materials as well as to vascularization. The MAPLE DW process has potential advantages over other patterning processes in providing a versatile technique to transfer a wide range of materials, with great accuracy, resolution, speed and efficiency. One issue that concerns all direct-write techniques is the need for accelerated tissue maturation. Rapidly applying adherent cells in a temporarily non-adherent (trypsinized) state will require a scaffold material be co-deposited to allow for immediate structural integrity and three-dimensional construct growth.

## Results

MAPLE DW has been used to form patterns and structures of living cells by optically selecting a group of cells from the ribbon and using the pulsed laser to transfer the cells to the receiving substrate.<sup>7</sup> Figure 2 shows an example of the transfer of MG-63 human osteoblasts transfer. This figure clearly shows that the laser effectively punches out a group of cells from the



**Figure 2.** MAPLE DW transfer of MG-63 human osteoblast cells.

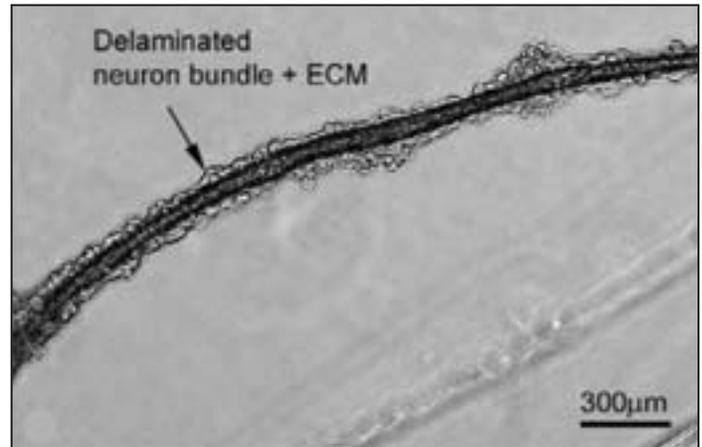
ribbon and transfers them intact. Both eukaryotic and prokaryotic cell patterns have been formed by MAPLE DW and under optimized conditions, near 100 percent viability has been achieved as determined by standard live/dead assays and green fluorescent protein marking. We have demonstrated successful transfer of a broad range of cell types including *E. coli*, Chinese hamster ovaries, human osteoblasts, mouse pluripotent cells and myoblasts, and rat neuroblasts. Using MAPLE DW we have also demonstrated the deposition of arrays of different cells in two-dimensional patterns, organic/inorganic scaffold and cell composites, and several cell layers have successfully been deposited on top of one another. Using ribbons with lower areal densities of trypsinized cells compared to that in Figure 2, and with a smaller laser spot size, it is possible to use MAPLE DW to deposit and carefully position single cells. In Figure 3 we show the deposition of a C2C12 mouse myoblast within 20 microns of a previously deposited B35 rat neuroblast. This is an important demonstration for the cell-by-cell construction of tissue constructs. In addition, the proximity of these different cells and the precision of their placement would allow the study of intercellular protein signaling pathways as well as the developmental cell biology of well-controlled systems.



**Figure 3.** Demonstration of MAPLE DW unique ability to place individual cells is shown. The cells are deposited from different ribbons and the myoblast is a mouse C2C12 myoblast and the neuroblast is a B35 rat neuroblast.

The equipment shown in Figure 1 can also be used to fabricate differentially adherent substrate surfaces. We used MAPLE DW to laser micromachine a channel on the surface of an agarose gel. The channel was filled with extracellular matrix and trypsinized neuroblasts were added. Within a short time

the neuroblasts migrated to the extracellular matrix and attached, grew and proliferated. After 72 hours, the increased cell density led to delamination of the entire channel and cell structure (see Figure 4). The original channel dimensions were preserved and the neuroblast bundle was obtained as a self-



**Figure 4.** Optical micrograph showing a delaminated self-sustained B-35 rat neuroblast bundle.

sustained network. Though this experiment took 72 hours, it does indicate material processing pathways for the fabrication of three-dimensional tissue constructs.

#### Conclusions

MAPLE DW was demonstrated to be a versatile technique to develop novel, multilayer, heterogeneous biomaterial patterns for engineering tissue constructs. There are many potential applications for this approach, including three-dimensional tissue constructs, tissue-based sensing of warfare agents and environmental toxins, novel cell-signaling platforms with protein identification capabilities, living microfluidic devices and hybrid biological motors, and ultimately the repair of damaged tissue via a computer-aided surgeon.

#### Acknowledgements

The authors both wish to gratefully acknowledge financial support from the Office of Naval Research.

#### References

1. R. Langer and J.P. Vacanti, *Tissue Engineering*, Science 260 (1993) 920.
2. R. P. Lanza, R. Langer, J.P. Vacanti, *Principles of Tissue Engineering* 2nd edition, Academic Press 2000.
3. V. Mironov, T. Boland, T. Trusk, G. Forgacs, and R.R. Markwald, *Trends in Biotechnology* 21 (2003) 157.
4. A. Pique and D. B. Chrisey, *Direct Writing Technologies for Rapid Prototyping Applications: Sensors, Electronics, and Integrated Power Sources*, Academic Press, New York, 2002.
5. D.B. Chrisey, A. Pique, R.A. McGill, J.S. Horwitz, B.R. Ringeisen, D.M. Bubb, and P.K. Wu, *Chemical Review* 103 (2003) 553.
6. www.atcc.org - EC Matrix Solution, Catalog No. 30-2501.
7. B.R. Ringeisen, H. Kim, J.A. Barron, D.B. Krizman, D.B. Chrisey, S. Jackman, R.YC. Auyeung, and B.J. Spargo, *Tissue engineering* 10 (2004) 483.

*D.B. Chrisey is at the Naval Research Laboratory, Washington, D.C., and can be reached at douglas.chrisey@nrl.navy.mil. A. Doraiswamy and R.J. Narayan are at the Georgia Institute of Technology, Atlanta, GA.*

# Early Career Translational Research Awards Given to Society Members by the Wallace H. Coulter Foundation

**Feature**  
By Martine La Berge

The Early Career Translational Research Awards in Biomedical Engineering, supported by the Wallace H. Coulter Foundation, are designed to support biomedical engineering research that is translational in nature, and to encourage and assist eligible biomedical engineering investigators as they establish themselves in academic research careers with two years of funding. The Wallace H. Coulter Foundation is a private, nonprofit foundation dedicated to improving human healthcare by supporting translational research in biomedical engineering—research directed at the transfer of promising technologies within the university research laboratory that are progressing towards commercial development and clinical practice.

The 23 recipients of the first Early Career Translational Research Awards are full-time, tenure-track faculty members with a primary appointment in biomedical engineering. They have received their doctoral degree no more than six years prior to their application, and they held a rank no higher than assistant professor at the time of application. Biomaterials research has

been highly recognized by the Wallace H. Coulter Foundation as being translational, and numerous awards were made for innovative biomaterials research (see chart).

Wallace H. Coulter was an engineer, inventor, and entrepreneur who applied engineering principles to a biomedical problem. He founded Coulter Corp., which developed and marketed the first automated blood cell counters and flow cytometers, instruments that revolutionized healthcare diagnostics and therapeutics. Coulter Corp. became the global industry leader; its mission of “Science Serving Humanity” was based on Wallace’s belief that laboratory discoveries must be developed into commercially viable products to truly benefit humanity. Believing that the contributions of engineers to solving biomedical problems were generally under-recognized, Wallace mentored and encouraged young engineers to dream, take risks, and be innovative.

The Society For Biomaterials congratulates all recipients of 2005 Early Career Translational Research Awards.

Awardee	Institution	Project Title
Guillermo Ameer	Northwestern University	Biocompatibility Enhancement of ePTFE Vascular Grafts: A Tissue Engineering Approach
Xinyan Cui	University of Pittsburgh	Conducting Polymer/Hydrogel Skin Surface Electrode for High Resolution Multichannel EEG
Karen Haberstroh	Purdue University	<i>In vivo</i> Efficacy of Nano-structured Bladder Tissue Replacement Constructs
Tao Lowe	Pennsylvania State University	Subconjunctivally Implantable Hydrogels for Sustained Drug Delivery to Treat Diabetic Retinopathy
Helen Lu	Columbia University	Novel Tissue Engineered Triphasic Scaffold for the Biological Fixation of Tendon Grafts to Bone
Shelly Sakiyama-Elbert	Washington University, St. Louis	Rationally Designed Delivery Systems for Nerve Injury
Thomas Webster	Purdue University	Bionanotechnology for the Improvement of Orthopedic Implants
Xuejun Wen	Clemson University	A Tissue-engineered Multifilament Entubulation Bridging Device for the Treatment of Spinal Cord Injury

**Aastrom Biosciences Inc.**, Ann Arbor, Mich., announced the results from its feasibility clinical trial conducted with the Institut de Teràpia Regenerativa Tisular (ITRT) in Barcelona, Spain, to evaluate the use of Aastrom's Tissue Repair Cells (TRCs) for the treatment of severe long bone non-union fractures. The patients treated with Aastrom's TRCs, an autologous bone marrow-derived cell product, exhibited clinical and functional healing, with five of six treatments showing bone regeneration at the fracture site as determined by radiographic imaging by six months. The results were notable in that each patient had failed prior treatment with standard of care methodologies and had a poor prognosis for healing. This feasibility trial suggests that Aastrom's autologous TRCs may offer a new way to achieve local bone regeneration for bone grafting and other clinical indications for bone repair.

**Archimedes**, Oakland, Calif., a Kaiser Permanente innovation, is part of an exciting launch of a ground-breaking preventative-health tool—one that will allow individuals to predict their risk of getting diabetes or its complications. Launched in close partnership with the American Diabetes Association, Diabetes PHD (Personal Health Decisions) is driven by the Archimedes Model. This online, interactive tool provides instant, highly accurate health profiles for people with, or at risk of, developing diabetes. It can be accessed at no cost by the general public through the ADA's Web site at [www.diabetes.org/diabetesphd](http://www.diabetes.org/diabetesphd), and by Kaiser Permanente members at <http://kaiserpermanente.org/diabetes>.

**Archus Orthopedics Inc.**, Redmond, Wash., announced successful completion of the first clinical implants of its Total Facet Arthroplasty System™ ("TFAS"). The TFAS, which is a novel, patented spinal implant designed to treat spinal stenosis, replaces the degenerative facet joints with a prosthetic joint implant intended to restore stability and normal motion to the spine, eliminating the need for fusion. On March 28, 2005, the U.S. Food and Drug Administration conditionally approved an Investigational Device Exemption for the TFAS, allowing the company to initiate a pivotal clinical trial of the device in the United States.

**Biosensors International Group Ltd.**, Singapore, a manufacturer of innovative medical devices used in interventional cardiology and critical care procedures, announced the results of a 12-month safety clinical trial that found its BioMatrix™ Drug-Eluting Stent ("DES") to be safe and effective with the new device reducing the occurrence of restenosis in over 97 percent of patients studied. More than 93 percent of patients who received the BioMatrix DES experienced freedom from the adverse events of death, heart attack, and target lesion revascularization ("TLR") during the 12-month study. The clinical trial results were reported at the EuroPCR '05 held in Paris May 24-27, 2005.

First, nanotechnology researchers at **Cornell University** built a device so sensitive it could detect the mass of a single bacterium—about 665 femtograms. Then they built one that could sense the presence of a single virus—about 1.5 femtograms. Now, with a refined technique, they have detected a single DNA molecule, weighing in at 995,000 Daltons—a shade more than 1 attogram—and can even count the number of DNA molecules attached to a single receptor by noting the difference in mass. The devices, which fall in the class of nanoelectromechanical systems (NEMS), could be made even more sensitive through increased miniaturization, the researchers say. The technology, they suggest, can be combined with microfluidics to

*Continued on page 15*

### Position Title/Rank:

Asst/Assoc Professor

### Division:

Faculty of Dentistry

### Department:

Biomaterials Science and Engineering

### Deadline:

September 30, 2005

### Job Description:

The Faculty of Dentistry and the Department of Materials Science and Engineering, in conjunction with the Institute of Biomaterials and Biomedical Engineering, jointly invite applications for a tenure-stream position in Biomaterials with an emphasis on structure/property relationships for metallic and/or ceramic materials. Of particular interest is research in the area of nano-structured materials design.

Applicants are expected to have a Ph.D. or equivalent with demonstrated innovation in the design and production of novel metals and/or ceramics. Applicants should have a strong interest in pursuing cross-disciplinary research in the biomaterials field, and leading an interdisciplinary research program at the interface of engineering and medicine/dentistry. The applicant is expected to have excellent teaching skills and be capable of instructing at both the undergraduate and graduate levels. Collegial interaction will be an important attribute since the successful candidate is expected to collaborate with a range of academics of varied expertise.

Rank, tenure status, and salary would be commensurate with the candidate's qualifications and academic accomplishments. The candidate will be appointed to both the Faculty of Dentistry and the Faculty of Applied Science and Engineering with a cross-appointment within the Institute of Biomaterials and Biomedical Engineering (IBBME). Applicants should send their curriculum vitae and a statement concerning their research and teaching interests (3-5 pages in length), and must arrange to have three letters of reference sent directly to the following address:

Dr. J. Paul Santerre Professor of Biomaterials,  
Dentistry/IBBME Associate Dean Research, Faculty of  
Dentistry, University of Toronto, 124 Edward Street,  
Toronto, Ontario M5G 1G6

For additional information regarding the position please contact Dr. J. Paul Santerre: Email: [paul.santerre@utoronto.ca](mailto:paul.santerre@utoronto.ca)

The University of Toronto is strongly committed to diversity within its community and especially welcomes applications from visible minority group members, women, aboriginal persons, persons with disabilities, members of sexual minority groups, and others who may contribute to further diversification of ideas. All candidates are encouraged to apply; however, Canadians and permanent residents will be given priority



**The Definitive Resource for Relevant Research in Biomedical Engineering**

## **ANNUAL REVIEW OF BIOMEDICAL ENGINEERING®**

VOLUME 7, AUGUST 2005 — AVAILABLE ONLINE AND IN PRINT

The *Annual Review of Biomedical Engineering*, in publication since 1999, covers the significant developments in the broad field of Biomedical Engineering, including Biomechanics, Biomaterials, Biocomputing, Bioelectrical Engineering, Biochemical Engineering, and Biomedical Imaging topics.

The *Annual Review of Biomedical Engineering* is ranked #1 by impact factor of the 42 Biomedical Engineering publications assessed by the ISI® Journal Citation Reports (JCR®).

**Editor:** Martin L. Yarmush, *Center for Engineering in Medicine, Massachusetts General Hospital/Harvard Medical School*

**Associate Editors:** Kenneth R. Diller, *University of Texas, Austin*

Mehmet Toner, *Center for Engineering in Medicine, Massachusetts General Hospital/Harvard Medical School*

**Editorial and Planning Committee Members:**

Thomas F. Budinger, *University of California, Berkeley* | Shu Chien, *University of California, San Diego* | Katherine Ferrara, *University of California, Davis* | Don Giddens, *Georgia Institute of Technology* | Martha L. Gray, *Massachusetts Institute of Technology* | Thomas R. Harris, *Vanderbilt University* | Michael R. Neuman, *Michigan Technological University*

**PLANNED CONTENTS AND AUTHORS FOR VOLUME 7 INCLUDE:**

- **Biochemistry and Biomechanics of Cell Motility,**  
*Song Li, Jun-Lin Guan, Shu Chien*
- **Blood-on-a-Chip,** *Mehmet Toner, Daniel Irimia*
- **Deterministic and Stochastic Elements of Axonal Guidance,** *Susan Maskery, Troy Shimbrot*
- **DNA Mechanics,** *Craig J. Benham, Steven P. Mielke*
- **Functional Electrical Stimulation for Neuromuscular Applications,**  
*P. Hunter Peckham, Jayme S. Knutson*
- **In Vivo Magnetic Resonance Spectroscopy in Cancer,**  
*Robert J. Gillies, David L. Morse*
- **Instrumentation Aspects of Animal PET,**  
*Yuan-Chuan Tai, Richard Laforest*
- **Molecular Mechanics and Dynamics of Leukocyte Recruitment During Inflammation,**  
*Scott I. Simon, Chad E. Green*
- **Quantum Dots as Cellular Probes,**  
*A. Paul Alivisatos, Weiwei Gu, Carolyn Larabell*
- **Retinal Prosthesis,** *James D. Weiland, Wentai Liu, Mark S. Humayun*
- **Structure and Mechanics of Healing Myocardial Infarcts,**  
*Jeffrey W. Holmes, Thomas K. Borg, James W. Covell*
- **Werner Goldsmith: Life and Work (1924–2003),**  
*Stanley A. Berger, Albert I. King, Jack L. Lewis*

Note: A current individual print subscription includes online access to the full text content in the current volume and 4 years of back volumes.

Contact Annual Reviews for institutional pricing and site license options.

**ACCESS THIS SERIES ONLINE NOW AT [HTTP://BIOENG.ANNUALREVIEWS.ORG](http://bioeng.annualreviews.org)**

**MEMBERS OF THE SOCIETY FOR BIOMATERIALS: ORDER TODAY AND SAVE 30%!**

*Annual Review of Biomedical Engineering* | Volume 7 | August 2005 | ISSN: 1523-9829 | ISBN: 0-8243-3507-4

**SOCIETY FOR BIOMATERIALS INDIVIDUAL MEMBER PRICE (US/INT'L): \$53.20/\$56.70**

Regular Individual Price (US/Int'l): \$76/\$81 | Handling and applicable sales tax additional.

Mention priority source code **JASBM05** when placing your order. Order via phone, fax, email, or online.



**ANNUAL REVIEWS** | Intelligent Synthesis of the Scientific Literature

Call: 800.523.8635 (Toll Free US/CAN) | Call: 650.493.4400 (Worldwide) | Fax: 650.424.0910

Email: [service@annualreviews.org](mailto:service@annualreviews.org) | Order Online at [www.annualreviews.org](http://www.annualreviews.org)

## Biolnk

(Continued from page 13)

perform genetic analysis of very small samples of DNA, even the amount present in a single cell. Current techniques for genetic analysis require small samples of DNA to be replicated many times through a process called PCR amplification. DNA analysis can be used, among other things, to detect genetic markers for cancer susceptibility.

**Jivan Biologics** Inc., Berkeley, Calif., a privately held company, launched the first commercial genome-wide microarrays for alternate splicing. Manufactured by **Agilent Technologies** and available as a catalogue product, Jivan's TransExpress™ Whole Spliceome enables researchers to detect changes in RNA splicing across the entire human genome for a broad range of clinical and research applications. By differentiating among the splice isoforms of a gene, TransExpress Whole Spliceome multiplies the number of potential clinical biomarkers and molecular diagnostics by a factor of four or more compared with conventional gene arrays.

Scientists at the **Kenya Agricultural Research Institute (KARI)** have for the first time in the country's history of agricultural research planted biotechnology-derived maize in a field trial. The trial of the maize variety, which is resistant to stem borer, is undertaken by the Insect Resistant Maize for Africa (IRMA) project, a joint research project of KARI and the **International Maize and Wheat Improvement Centre (CIMMYT)** supported by the Syngenta Foundation for Sustainable Agriculture and the Rockefeller Foundation. The success of the undertaking would reduce maize loss resulting from destruction by the stem borer, which accounts for 40,000 tons of maize annually, about 13 percent of the annual cereal loss, or some 5.6 billion Kenya shillings.

**Targeptics** Inc., Hershey, Pa., announced the issuance of U.S. Patent No. 6,884,603 for its genetically modified, mutated interleukin 13 (IL-13) technology platform for the treatment of malignant glioma, a brain tumor that impacts 17,500 people annually and has a \$200 million annual market. These mutated IL-13 compounds were designed to provide greater specificity towards the IL-13 receptor that is over-expressed in brain tumors while sparing normal tissues. The more specific targeting should allow broader and safer application of recombinant cytotoxins than the first generation, wild-type IL-13-based compound, hIL13-PE38QQR.

New research from **University of North Carolina at Chapel Hill** shows how a protein called "eed" is needed for an essential chemical modification of many genes. Embryos cannot survive without the modification. The research offers an important contribution to a new wave of thinking in genetics: that not all human disease states are due to alterations in DNA sequence. Epigenetic inheritance is heritable information passed down through generations of cells that is not encoded by the DNA sequence. This information is in the form of chemical modifications on any of four core histone proteins that group together to provide a molecular scaffold supporting the roughly 35,000 genes in the nucleus of every human cell. Histone modifications affect gene activity and include methylation, in which a methyl component is attached to the histone protein. eed is the first protein shown to be required for the addition of a single methyl group to histone H3. Knowing which proteins are responsible for the various histone modifications is the first step toward understanding how epigenetics influences such occurrences as cancer and birth defects.

45 year history of serving the needs of  
the Medical Device Industry

## Experts in Processing Biomaterials



World Class Customer Service with the Experience to Contract Manufacture your most basic ABS Disposable Delivery System to your most complex Bioresorbable/Bioabsorbable or PEEK-Optima<sup>®</sup> Polymer product lines. Coupled with our Assembly, Labeling and Packaging Capabilities we save you time and money on your Finished Product.

*Certified*

ISO9001:2000 ISO13485:2003

*Experienced*

45 years in implantables

*Registered*

FDA Reg#2183967



*The Safe Choice for  
Medical Device Plastic  
Molding*

Project Questions, call Kyle at  
952 927-2424 or email  
kncvala@mpc-medical.com

www.mpc-mn.com

Minneapolis, MN 55426

*From basic components to complex  
implantables; your one stop solution*

# Community Calendar

---

**American Society for Bone and Mineral  
Research 27th Annual Meeting**

September 23-27, 2005  
Gaylord Opryland Resort and  
Convention Center  
Nashville, TN  
(202) 367-1161  
asbmr@smithbucklin.com  
www.asbmr.org

---

**American Society for Metals,  
International Materials & Processes  
for Medical Devices Conference**

September 25-28, 2005  
David L. Lawrence  
Convention Center  
Pittsburgh, PA  
(440) 338-5151  
www.asminternational.org

---

**Biomedical Engineering Society**

September 28-October 1, 2005  
Hyatt Regency  
Baltimore, MD  
www.bme.jhu.edu/BMES2005

---

**Surfaces in Biomaterials Foundation  
BioInterface 2005**

October 24-26, 2005  
Marquette Hotel  
Minneapolis, MN  
(651) 290-6267  
www.surfaces.org

---

**Osteoarthritis Research Society  
International 2005 World Congress**

December 8-11, 2005  
Marriott Copley Place  
Boston, MA  
(856) 439-1385  
oarsi@oarsi.org  
www.oarsi.org

---

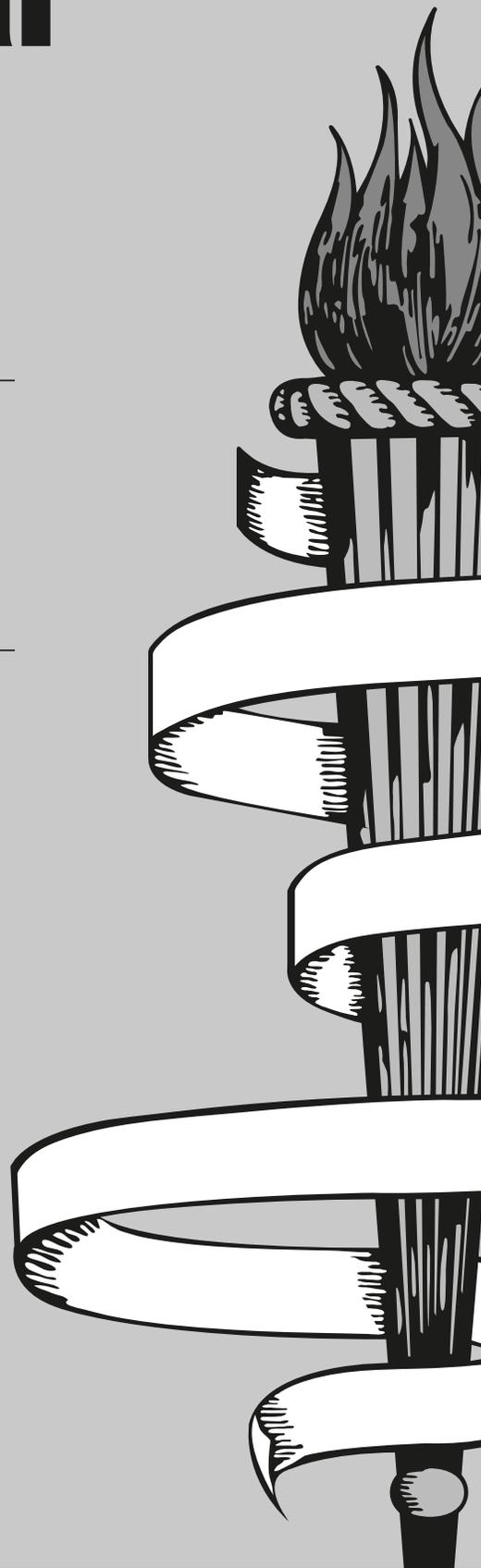
**Orthopaedic Research Society  
52nd Annual Meeting**

March 5-8, 2006  
Ernest N. Morial Convention Center  
New Orleans, LA  
(847) 698-1625  
ors@aaos.org  
www.ors.org

---

**Wound Healing Society 16th Annual  
Meeting & Exhibition**

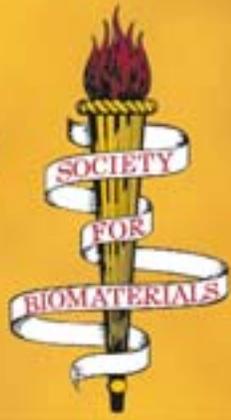
May 14-17, 2006  
Double Tree Paradise Valley  
Scottsdale, AZ  
(763) 765-2377  
meetings@woundheal.org  
www.woundheal.org



Society For Biomaterials

# 2006 Annual Meeting

April 27 - 30, 2006  
Pittsburgh, Pennsylvania



*"Reflecting and enhancing the diversity and value of our membership"*



PITTSBURGH, PENNSYLVANIA

Society For Biomaterials

# SFB

Please visit [www.biomaterials.org](http://www.biomaterials.org)  
for updated meeting information.

# For Tissue Engineering, the *choice* is Bose®

Discover the next-generation multi-axial BioDynamic™ Test Instrument for characterization of biomaterials and tissues in a biological environment. The BioDynamic instrument can be used to simulate in vivo conditions for the culture and testing of three-dimensional samples and as a result, it can be a valuable tool to bridge the gap between exploratory studies in culture dishes and in vivo animal experiments.



Dual-Axis BioDynamic™  
Test Instrument

**ElectroForce® Test Instruments - The new standard for medical device testing.**



Coronary &  
Peripheral Stent  
Testing



Multi-wire  
Fatigue Testing



Planar Biaxial  
Tissue Testing

**BOSE®**  
Better products through research.

Bose Corporation – EnduraTEC Systems Group  
5610 Rowland Road, Minnetonka, Minnesota 55343 USA • 952.278.3070  
www.enduratec.com • electroforce@bose.com