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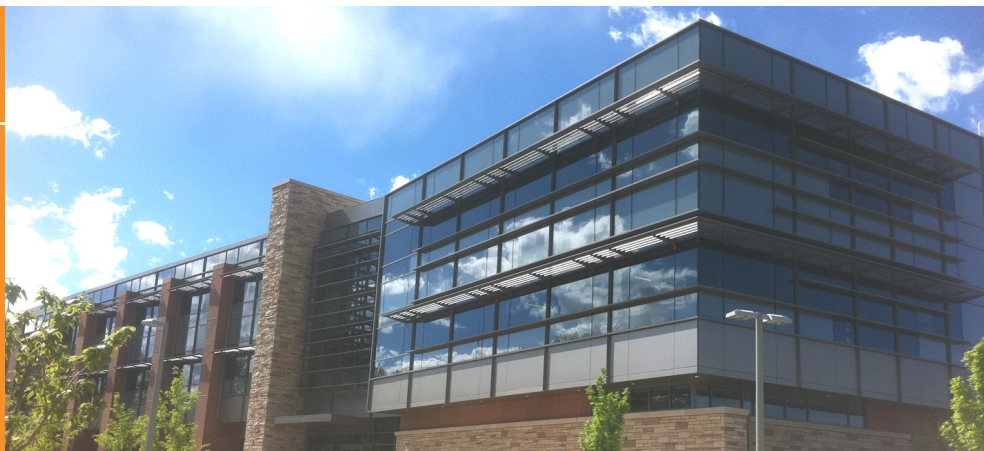
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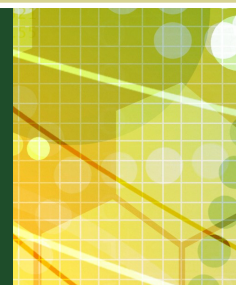


Volume 4, Issue 1

Spring 2016



Colorado State University
SCHOOL OF BIOMEDICAL ENGINEERING



visitors >>>

The Company We Keep

Each semester, the School of Biomedical Engineering invites distinguished professors from around the world to speak on biomedical engineering research and related disciplines for its weekly seminar series. The Fall 2015 speakers included:

Dr. Jeffrey Jacot

Rice University

"Engineering Heart Tissue for Correction of Heart Defects"

Dr. Paul Campagnola

University of Wisconsin, Madison

"Imaging and Modeling the Extracellular Matrix in Human Ovarian Cancer"

Dr. Bob Tranquillo

University of Minnesota

"Cardiovascular Tissue Engineering Based on Cell-Remodeled Biopolymers"

Dr. Nancy Allbritton

University of North Carolina

"Microengineered Devices for Cells, Tissues, and Organs"

Message from Director

Acknowledging women and their impact on BME



This past fall, as we welcomed our incoming biomedical engineering class, we saw an increase in female students. Out of 127 incoming freshmen,

52% are female. We were reminded of their different abilities, backgrounds, demographics, ethnicity, experiences, and learning styles. Several of these students are first generation, many come from out of state, and their interests also span three traditional engineering areas—chemical and biological, electrical, and mechanical.

As we witness an increase in female students, there is no better time to assess the growing achievements made by female SBME professors at Colorado State.

In 2015, Nicole Ehrhart was the first woman at CSU appointed to an endowed university chair. University Distinguished Professor Carmen Menoni continues to receive numerous awards for her internationally recognized

research in optics and for her impressive record in recruiting and mentoring CSU women and minority students. Susan James, founding SBME director, currently leads the Department of Mechanical Engineering, the largest department in the College of Engineering and third largest on campus. Melissa Reynolds is actively translating academic research into real-world solutions through her collaborative efforts with local physicians including Julie Dunn, medical director of trauma research and education at the Medical Center of the Rockies. Dunn is also the newest member of the SBME Advisory Board.

Yes, it is a thrilling time for all of us as we see more women serving as role models for future generations. Our female students are taking leadership roles too, as our BMES Student Chapter President Mahli Ruff and Vice President Tegan Walsh have shown. We hope these stories will inspire you to continue, restart, or begin your engagement with the School of Biomedical Engineering.

Graduate Programs

In Fall 2015, we hosted a resume review and writing event for our graduate and undergraduate students. During this event, students had the opportunity to share their cover letters and resumes with SBME Advisory Board members and to receive valuable feedback. The students unanimously agreed it was an incredibly valuable experience to interact one-on-one with prominent industry leaders in this way. This event will be offered annually.

Several of our graduate students attended the annual Biomedical Engineering Society meeting in Tampa, Florida in October. Stacy Willett (M.S., 2016) was chosen for a platform presentation. Other students presented posters. SBME Director Stuart Tobet and Undergraduate Director Kevin Lear participated in two panel discussions showcasing unique characteristics of our programs at both graduate and undergraduate levels.

Earlier this year, we hosted our annual Graduate Interview Days. Fifteen diverse and talented individuals from around the

world attended the event and interviewed for openings in our Ph.D. and M.S. programs. During the two day event, students met with select faculty and SBME Advisory Board members and participated in campus and lab tours. In addition, students attended a poster session that included current student projects and awards. This event provided an opportunity for prospective students to socialize with and solicit information from current students, faculty, and staff.

Beginning Spring 2017, Dr. Arun Kota will teach BIOM 574 Bio-Inspired Surfaces online. This course teaches students how to analyze surface functionalities of various biological species and identify design principles for such surfaces. To view online BME offerings, visit: <http://www.online.colostate.edu/degrees/biomedical-engineering/curriculum.dot>.



Sara Neys Mattern, advisor,
SBME Graduate Programs

Grad Day Poster Session & Awards

On Monday, February 29, the School of Biomedical Engineering hosted its annual Graduate Interview Day Social for Ph.D. candidates seeking admission to the bioengineering program.

At the event, current students showcased their research while faculty, prospective students, and SBME advisory board members mingled and judged student posters. Prizes were awarded to students with the best posters.

Rachel Simon-Walker was awarded the Student Academic Award.

Hannah Pauly and **Raimundo Romero**, Ph.D. candidates, tied for Outstanding Graduate Student Award.

Hannah Pauly also received the Best Poster Award.

Assistant Professor **Arun Kota**, was awarded the Excellence in Teaching Award. He holds joint faculty positions in the School of Biomedical Engineering and Mechanical Engineering.



faculty update >>>

New SBME Faculty



Jesse Wilson is an assistant professor for the Department of Electrical

and Computer Engineering and recently joined SBME as a core faculty member. He earned his Ph.D. in Randy Bartels' lab at Colorado State, developing techniques in ultrafast pulse shaping and impulsive Raman spectroscopy. After that, he joined Warren Warren's lab at Duke University as a postdoc, where he has

been awarded both the JenLab Young Investigator Award from SPIE and a Ruth Kirchstein Fellowship from the National Cancer Institute. He is interested in leveraging ultrafast and nonlinear optical phenomena for microscopic imaging contrast, with a specific focus on cancer imaging.



Brian Geiss joined the School of Biomedical Engineering as an associate

faculty member. He is an

assistant professor in the Department of Microbiology, Immunology, and Pathology. Brian's research interests include understanding viruses at a molecular level and discovering how they replicate. He will serve as an infections disease expert, helping biomedical engineering students become more familiar with this subject area and microbiology. He also plans to develop new avenues for research through his collaborative interactions with SBME faculty.

Undergraduate Programs

Perhaps you recall a science class where you were first introduced to exponential population growth. Often there was an accompanying message that the trend could not continue forever since resources such as food are finite. While the growth of the biomedical engineering (BME) cohorts, shown in the figure below, is closer to linear than exponential, even that trend requires commensurate growth in resources. When those resources, including faculty, classrooms, and laboratory space, are constrained, it is wise to moderate growth to maintain high quality education. This is precisely the situation facing one of our partner departments, mechanical engineering (ME), which now has nearly 1,000 students.

Accordingly, admissions to the ME major were capped this year. To prevent BME students from swamping the ME department, admissions to the BME+ME degrees program were also capped. Capped programs are new to the College of Engineering, although not CSU where the biomedical sciences major has been capped for a number of years. Our combination programs with chemical and biological engineering (BME+CBE) and electrical engineering (BME+EE) remain uncapped. By design, we do not allow students to major in only BME. If you know any prospective students interested in BME+ME, please give them extra encouragement to apply early to this program since it is filled with qualified

applicants on a first-come, first-admitted basis.

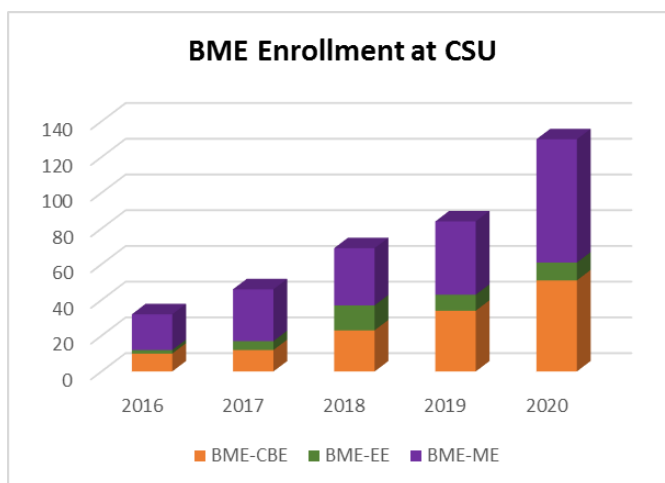
Our multiple programs provide some interesting data on BME student inclinations as well as creative solutions in working with resource constraints. The stacked bars in the graph are color-coded to show the distribution of students between the three BME partner degrees. The strong overlap in student interests between BME and CBE has resulted in over half of all CBE students also being BMEs. The total number of students enrolled in BME+CBE and BME+ME are comparable although the fraction of MEs also majoring in BME is much smaller, approximately one-fifth. BME+EE is the shortest segment of the bars in the chart, and about one-quarter of all EEs are also in BME. Given the constraints in ME, future enrollment

fall are about three times higher than in previous years.

In fact, as we grow BME+EE, we need to address initial conceptions of high school students. Ask a group of prospective students how biomedical engineers could help people, and "prosthetics" will be one of their first answers. And what they typically envision as they say that word are mechanical limb replacements. Part of our mission as educators is to broaden their perspective, for example by leading them to consider neural interfaces for those prostheses. The operational principles of electronics are less immediately tangible than those of robotic arms, and thus harder for high school students to visualize. To compensate, we've expanded the range of activities we do with high school students to not only include prototyping prosthetic feet but also building pulse oximeters from circuit components. Hopefully, robotics clubs, earlier introduction to computer programming, and figuring out how to make all those 3-D printed gizmos move will also spread the wealth of engineering interest. Together, we can expose students to a wider range of ideas about how they, as future biomedical engineers, can improve human and animal health, a common motivation for all of us.



Kevin Lear, director, SBME Undergraduate Programs and Brett Beal, senior undergraduate advisor



increases will be driven by continued growth in BME+CBE and acceleration in BME+EE. The ME cap may already be encouraging a shift as students paying a deposit to join the BME+EE program this

Third Annual First Generation Dinner for BME Students

Over 20 students and ten faculty and staff members attended the third annual BME First Generation Dinner in February to share inspirational experiences and strengthen relationships to help students succeed. Dolly Ricapor (B.S.B.M.E.+ B.S.M.E., 2019) reflected that, "as an attendee of this dinner, I was able to personally connect with SBME professors and other faculty who were also first generation students. Many of them shared stories about being the first child in their family to go to college, which I very much could relate to. I am a first-generation transfer student from Hawaii so the transition to CSU was a big change for me. At this dinner, I was able to land a volunteer position in one of the bioengineering labs thanks to Rachael Simon-Walker, a graduate student, and Dr. Popat. This gathering connected a handful of other first generation students and also opened up many opportunities."

New SBME Advisory Board Members



APRIL GILES

April is the President and CEO of the Colorado Bioscience Association. She joined the organization in 2006 as the Director of Operations and within five years, she became the Executive Vice President. For the past ten years, April has grown the organization from a small startup to a mature and

successful organization.

At CBSA, April focuses on the cultivation of community partnerships, workforce pipeline programs, provides strategic guidance to industry partners, the state's office of economic development, as well as advocacy at both the state and federal levels.

April launched the first-ever Rocky Mountain Life Science Investor & Partnering Conference with Johnson and Johnson Development Corporation in 2009 which has garnered millions of additional investment into Colorado bioscience companies and continues as a valued conference. Additionally, she developed the 501c3 Colorado Bioscience Institute, as a related entity to the Association, setting strategy for Institute initiatives, and developing partnerships with local and national organizations related to workforce training and STEM programs.



JULIE DUNN, M.D., F.A.C.S.

Julie works for University of Colorado Health as the medical director of trauma research and education at Medical Center of the Rockies in Loveland, Colorado. In addition, she is a trauma and general surgeon for Colorado Health Medical Group.

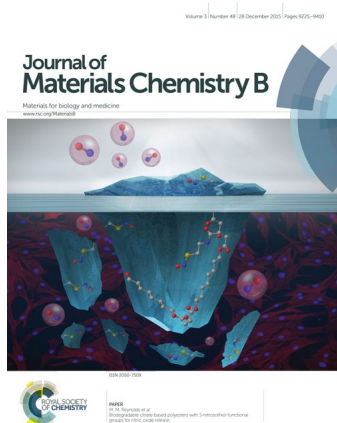
Julie serves on the National Committee on Trauma for the American College of Surgeons. She is also Out-of-State Site Reviewer for the Tennessee Trauma Center Inspection Team. In addition, Julie is the chair for the State of Colorado Committee on Trauma of the American College of Surgeons.

Prior to joining MCR in 2011, Julie spent 13 years teaching at the James H. Quillen College of Medicine at East Tennessee State University. In 1998, she began as the assistant professor of surgery and four years later was promoted to assistant professor of surgery. In 2010, she became a professor of surgery.

Since 2012, Julie has served as an affiliate faculty member for the School of Biomedical Engineering at Colorado State, actively engaging in collaborative efforts with SBME faculty.

acknowledgement >>>

Research Team Makes Cover of Prestigious Journal



This December 2015 cover of the *Journal of Materials Chemistry B – Materials for Biology and Medicine* features research from Associate Professor Melissa Reynolds' Therapeutic Materials and Biointerfacial Research team at Colorado State University. Reynolds holds a joint appointment in the Department of Chemistry and the School of Biomedical Engineering. Research team members include graduate students Pam Yapor, Alec Lutzke, and Bella Neufeld, and postdoctoral researchers, Dr. Vinod Damodaran and Dr. Dori Pegalajar-Jurado. The research team was sought out for their "good work" on their paper titled, "Biodegradable citrate-based polyesters with S-nitrosothiol functional groups for nitric oxide release." They are extremely excited for this acknowledgement and recognition. Full article can be found here: <http://pubs.rsc.org/en/Content/ArticleLanding/2015/TB/C5TB01625H>.

Class Notes

Celso Duran ('13 M.S. Bioengineering) began working in the medical device industry in 2013. As a product associate in regulatory affairs, he is responsible for working with project teams throughout the device process, obtaining 510(k) clearance from the FDA, preparing the MDD Technical File, and writing global regulatory strategies. Celso spends his free time rock climbing, traveling, and hiking.



Ali Senz ('15 M.E. Engineering) began working as an operations engineer at Mighty Oak Medical Englewood, Colorado on February 1, 2016. In this position, she is part of a team that aims to optimize the design processes of patient-specific pedicle screw guides, a technology referred to as *firefly*. Firefly is a patent-specific, 3D printed physical guide for screws.

Keep your former classmates informed of your accomplishments and achievements! Share your new job, promotion, award, patent, further education, volunteer work, marriage, birth, or any accomplishment. We encourage alumni to send along a high-resolution photo of at least 300 dpi when submitting stories. Submit to Allison.Robin@colostate.edu.

student worker update >>>

Farewell Felicia



Felicia Leonard ('15 B.S. Zoology) has served as the SBME's student worker since Fall 2012 and has played a valuable role in supporting administrative functions of our office. She has served as an asset to our office over the years and we are sad to see her go. However, we are extremely proud of Felicia, as she recently graduated from CSU with a Bachelor of Science in Zoology and will be returning in the fall to begin her studies in the Doctor of Veterinary Medicine program. Currently, she is completing an internship at the Denver Zoo.

fun facts >>>

Female Faculty Top Contributors

The School of Biomedical Engineering is proud to boast a high percentage of faculty innovators. Twenty-two percent of inventions disclosed to CSU Ventures, the technology transfer office for the University, are created by SBME faculty. The biggest, and perhaps most impressive news is knowing 100 percent of our female biomedical engineering professors are represented in this number. You can find a list of innovations by visiting <http://csuventures.org/for-investors/startups/existing-startups/>. If you are interested in collaborating with these brilliant minds, please contact SBME Director Stuart.Tobet@colostate.edu.



Meet the New Undergraduate Advisor

Debra Misuraca is a new part-time undergraduate academic advisor with the SBME. She also works with students who are pursuing the BME Minor. Debra has a background in undergraduate academic advising and service leadership programming and a passion for supporting students as they navigate their college experiences and develop academically, personally, and professionally.

Originally from St. Louis, Missouri, Debra graduated with a B.A. in communications from the University of Missouri-Columbia, an M.A. in higher education with a concentration in student personnel administration, and an M.A. in counseling from Saint Louis University. Debra is excited to have joined the SBME team and looks forward to exploring all that Fort Collins has to offer. She can be reached at Debra.Misuraca@colostate.edu.

SBME Faculty Research & Awards



Heart Valve Research Moves to Next Phase in India

Researchers at Colorado State University and Ohio State University in the United States and PSG Institute of Medical Sciences and Research in India are working on developing low-cost replacement heart valves that promise to be superior to current mechanical and tissue-based heart valves and reduce patients' need for medication to prevent blood clots. This consortium is supported by a two-year joint grant from the National Institutes of Health in the United States and the Department of Biotechnology in India.



V. Chandrasekar

Lakshmi Prasad Dasi, who is on the faculty of the School of Biomedical Engineering at CSU as well as on the faculty at OSU, is the principal investigator leading the U.S. efforts while cardiothoracic surgeon Dr. P.R. Murugesan is principal investigator leading the Indian efforts. Together with their team members they are working toward realizing a revolutionary heart-valve design superior to current heart valve alternatives for young patients particularly from low-resource settings.

V. "Chandra" Chandrasekar, a University Distinguished Professor, professor of Biomedical Engineering and Electrical and Computer Engineering, and associate dean for International Research in CSU's College of Engineering, leads the management of this unique international collaboration. Co-investigators on the project are Susan James, head of the CSU Department of Mechanical Engineering and an expert in polymer synthesis; and CSU Associate Professor

Ketul C. Popat, an expert in bio-compatibility and surface nano-engineering who is also on the faculty of the School of Biomedical Engineering. Dasi, James, and Popat invented the core technology for this project. To read the full story, visit: <http://source.colostate.edu/heart-valve-research-moves-to-next-phase-in-india/>.

Programmable Plants: Synthetic Biologists Pave Way for Making Genetic Circuits

In electronics, even the most advanced computer is just a complex arrangement of simple, modular parts that control specific functions; the same integrated circuit might be found in an iPhone or in an aircraft. Colorado State University scientists are creating this same modularity in – wait for it – plants, by designing gene "circuits" that control specific plant characteristics – color, size, resistance to drought, you name it. The relatively new, interdisciplinary field is synthetic biology – the design of genetic circuits, just like in electronics, that control different functions and can be easily placed in one organism or the next. Most of today's synthetic biologists work with simple microorganisms, like E. coli or yeast.



A CSU team led by June Medford, professor of biology, and Ashok Prasad, associate professor of chemical and biological engineering and biomedical engineering, is doing the same thing, but in the much more complex biological world of plants. Plants in particular pose a special problem, Prasad explains, "not only is the biology much more complicated than single-celled microorganisms, they are also slow to grow and develop. As a consequence, just testing different genetic circuits becomes a major undertaking."

Co-first author Katherine Schaumberg and co-author Wenlong Xu, both graduate students in biomedical engineering, handled all the data analysis for the project, and helped develop the mathematical model. "This was a true collaboration in which both sides participated fully in the entire endeavor, and should be a model for collaborations between computational modelers and experimental biologists," Prasad said. Read the full story here:

<http://source.colostate.edu/programmable-plants-synthetic-biologists-pave-way-for-making-genetic-circuits/>.

College of Engineering Faculty Awards



From Left: Dean McLean and Matthew Kipper

On November 3, 2015, Dean David McLean presented six faculty awards at the annual College of Engineering All-College Meeting. Four of the six awards were presented to SBME faculty. Carmen Menoni received the George T. Abell Outstanding Economic Contributions Award for the economic impact her work has brought to Colorado State. She plays a significant role in the college as a leader in economic development through innovation and invention. Christopher Snow received the George T. Abell Outstanding Early-Career Faculty Award for his research breakthroughs in the area of protein crystal synthesis. V. "Chandra" Chandrasekar received the Art Corey Outstanding International Contributions Award for his demonstrated global leadership, and Matthew Kipper received the College of Engineering Faculty Achievement Award for leading a highly effective interdisciplinary research program and for consistently receiving high ratings from students.

SBME Seminar Speaker Highlights

The purpose of the SBME Seminar course (BIOM 592) is to expose SBME graduate students to the breadth and depth of the field of biomedical engineering through presentations from academia and industry and to provide a forum where synergistic projects can be presented to educate and inspire faculty and students in further collaborative efforts. Students are required to post online summaries of the weekly presentations. We are proud to showcase the following summaries.

DR. JEFFREY JACOT

By: Kristen Jackson

Dr. Jeffrey Jacot from Rice University and Texas Children's Hospital presented "Engineered Heart Tissue for Correction of Heart Defects" on August 14, 2015. He is investigating ways to make patches for fatal birth heart defects that can be implanted once and avoid the need for multiple surgeries as the child grows.

Patches currently used for heart defect repairs are acellular so they eventually form scar tissue which does not support heart contraction nor electrical stimulation, and greatly increases chances of heart failure. Therefore, Dr. Jacot's lab is engineering heart tissue using amniotic fluid derived stem cells (AFSCs). By detecting heart defects prenatally, AFSCs can be isolated from the fetus, expanded, differentiated, seeded into a matrix construct, and used for surgical reconstruction in the same fetus to allow the patch to grow as the child does. Using a stable fibrin/PEG gel matrix and undifferentiated AFSCs, the lab gets the necessary differentiated cell types that form functional blood vessels.

Dr. Jacot also discussed how material properties of scaffolds affect cardiomyocytes. On gels stiffer than physiological levels, cardiomyocytes

have rearranged cytoskeleton, form stress fibers, and have lower calcium storage and therefore shorter action potentials. By tuning properties of scaffolds, a biomimetic multilayered patch of chitosan, heart matrix, and collagen has been constructed that allows cardiomyocytes to conduct electric signals almost as quickly as native heart cells. The lab is also incorporating carbon nanotubes to speed up electrical conduction.

Lastly, Dr. Jacot talked about strain conditioning of cardiomyocytes. Sheets of cardiac muscle tissue are grown and made stronger by stretching the muscle using liquid crystal elastomers that are voltage responsive. The various techniques Dr. Jacot discussed have led to advances in heart defect treatments and has promise to lead to engineering a whole heart that functions as a native heart does.

DR. BOB TRANQUILLO

By: Jasmine Nejad

Dr. Bob Tranquillo, head of the department of Biomedical Engineering at the University of Minnesota, presented "Cardiovascular Tissue Engineering Based on Cell-Remodeled Biopolymers" on October 19, 2015. Dr. Tranquillo discussed his work on engineered tissue replacements for small diameter arteries, heart valves, and myocardium.

Current cardiovascular tissue replacements require the use of anticoagulants, have limited durability, and are often inert, requiring subsequent surgeries, especially in pediatric patients. Dr. Tranquillo and his team are addressing these issues by creating engineered cardiovascular tissue equivalents that allow the patients' own cells to migrate into the scaffold.

To create a scaffold that is similar to

the native tissue, the team is using an innovative polymer molding technique that relies on contact guidance - the ability of cells to sense and align with fibers in their immediate environment. Entrapping native cells from relevant tissues in a fibrin biopolymer scaffold and applying appropriate mechanical constraints allows the cells to align with the fibers in a manner similar to that of the native tissue. Putting this scaffold through cycles of stretching and relaxing (cyclic distension) increases the strength and stiffness of the scaffold and stimulates the cells to secrete more collagen, an important structural protein in extracellular matrix. Using these methods, they were able to create tissue constructs that are stronger than the native tissue. Decellularizing these constructs provided a scaffold for the native cells to inhabit, eliminating immunogenic complications.

To test for biocompatibility and bioactivity in vivo, the tissue equivalents were implanted in sheep. The implants showed recellularization with no need for blood thinners and no sustained immune response after 24 weeks. Pediatric valves were implanted in lamb models to evaluate the ability of the implant to grow with the animal. Though the valves did not grow at the same rate as the host, Dr. Tranquillo's current research aims towards an improved pediatric valve implant.

Dr. Tranquillo's work shows promising advancements in the field of cardiovascular tissue engineering, which could significantly improve the treatment of cardiovascular disorders. His ongoing research on the development of pediatric valve replacements that can grow with the patient would eliminate the need for subsequent surgeries and drastically improve the outcomes and quality of life for children suffering from cardiac disorders.



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SBME Events Calendar

APRIL 2016

SBME Seminar: Dr. Martin Chalfie, Columbia University

Apr. 11 / 350A Lory Student Center Ballroom / 12–12:50 p.m.

Engineering Days (E-Days)

Apr. 15 / CSU Lory Student Center

SBME Seminar: Dr. Saad Khan, North Carolina State University

Apr. 18 / 229 Scott Bioengineering Building / 12–12:50 p.m.

MAY 2016

Commencement

May 13, 2016 / Moby Arena / 11:30 a.m.

giving opportunities >>>

Scholarships

Scholarship support at all levels provides critical aid to our students. We strive to help as many students as possible with the financial obligations of their engineering education.

Donate to an SBME scholarship today and know that your gift will make an impact for years to come.

SBME Scholarship for Leadership and Innovation

<https://advancing.colostate.edu/SBME>

Joan King Memorial Scholarship

<https://advancing.colostate.edu/KingScholarship>



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