RR

RESEARCH REVIEW: HIGHLIGHTS FROM PENN DENTAL MEDICINE 2017 RESEARCH CONFERENCES

ONCE AGAIN, we are pleased to present this special research supplement to the *Penn Dental Medicine Journal*. In it are highlights from four research meetings held by Penn Dental Medicine since the start of 2017, events that brought together leading researchers and clinicians from across the country and around the world. In June of this year, Penn Dental Medicine hosted two conferences — the Penn Periodontal Conference 2017 and the 2nd Biennial Meeting of the International Academy for Adhesive Dentistry. The inaugural Penn Stem Cell and Regenerative Dentistry Conference just recently took place this October; and this past May, our faculty and students gathered to share their work through the School's annual Research Day — a program that demonstrated the great depth of research activities within the Penn Dental Medicine community.

Creating such forums that facilitate the exchange of ideas among investigators and help build new collaborations is a vital part of the School's mission and important to our ongoing research growth and leadership. Whether building multidisciplinary collaborations between our own basic and clinical science departments, among colleagues from the other Penn schools, or with other universities and institutions here and abroad, it is this integration of knowledge that advances the science and practice of dental medicine and other fields as well.

The impact of the School's research and scholarship is far reaching with diverse applications. Within 2016, 160 research articles were published by Penn Dental Medicine's standing faculty members, while the depth the School's research continued to grow through faculty recruitment. New standing faculty members joined the departments of Anatomy & Cell Biology and Oral & Maxillofacial Surgery in 2016 and the departments of Periodontics and Microbiology to date in 2017. The new recruits considerably expand Penn Dental Medicine research in the bone field as well as research in clinical microbiology related to periodontal disease and cancer. The latter is an emerging research area that links microbial infection with the behavior of cancers.

We are also building upon the academic programs that promote research — from our DScD and MSOB degree programs for postdoctoral students to our research honors, summer research program, and dual-degree opportunity in translational research for our DMD students. In addition, this year we continued to enable students and young investigators to present their work on an international stage through the School's AADR/IADR Travel Grant Award program, with 10 DMD students and six postdoctoral and junior investigators attending the 2017 IADR/AADR/CADR General Session & Exhibition.

Indeed, Penn Dental Medicine is continuing to build on its position as an international leader in the generation of new knowledge and treatment modalities in oral health and beyond.

Dana Graves, DDS, DMSc
Vice Dean for Research and Scholarship; Professor, Department of Periodontics; Director, DScD Program

Since the start of 2017, four research meetings have been held at Penn Dental Medicine, bringing together researchers and clinicians from across the country & around the world.

Penn Periodontal Conference 2017

PENN DENTAL MEDICINE presented the third biennial Penn Periodontal Conference, June 25 – 30, drawing more than 200 attendees and providing a forum to exchange the latest research in the field of periodontics.

Penn Dental Medicine launched the first Penn Periodontal Conference in 2013 to not only bring together leading researchers in their respective fields of study but also to encourage the development of junior researchers working with them — that dual focus has continued to be a primary goal of the conference.

"We were honored to present this event and have the participation of a veritable who's who in periodontal and oral biology research," says Dr. Denis Kinane, Morton Amsterdam Dean of Penn Dental Medicine and Professor of Periodontics and Pathology. "It is inspiring to expose 'up and coming' researchers to such leaders in the field. The level of the science and the audience participation was highly impressive."

The program speakers represented 28 universities within the United States, Europe, Asia, and South America. The conference launched with an evening of presentations by junior researchers and the three-day scientific program featured a series of speakers each day addressing topics within the areas of regeneration and 3D printing, bone formation, microbiology, and host response. There was also a session on research updates and a day focusing on special topics in periodontics.

Highlights also included two keynote addresses — "Genetic and Translational Approaches to Cardiovascular Risk," presented by Dr. Daniel J. Rader of the University of Pennsylvania School of Medicine; and "Novel Topical Drug Delivery Approach to Enhance Oral Health," presented by Dr. Henry Daniel, Professor, Department of Biochemistry, from Penn Dental Medicine.

The program was structured to encourage interaction among participants, and a poster presentation session was an integral part of the conference, providing the opportunity for participating researchers to share their work and talk one-on-one with each other.

"I was very impressed by the lively discussions and the exchange of information. Several new and established concepts were examined that led to interesting conversations" notes Dr. Dana Graves, Vice Dean for Research and Scholarship and Professor, Department of Periodontics, who organized and hosted the event with Dean Kinane. "We welcomed postdoctoral researchers and PhD students along with highly accomplished researchers; such a forum is of critical importance to advances in our discipline and to career development."

The next Penn Periodontal Conference is anticipated to be held in 2019.

PENN PERIO 2017 PRESENTATION HIGHLIGHTS

We asked several speakers of the Penn Periodontal Conference 2017 to share some key highlights from their presentations.

Luiz Bertassoni, DDS, PhD, Division of Biomaterials and Biomechanics, School of Dentistry Center for Regenerative Medicine, School of Medicine Department of Biomedical Engineering, School of Medicine Oregon Health and Science University

Your topic?
My presentation addressed recent developments on the engineering of bone scaffolds that are 3D printed with long blood vessels homogeneously distributed inside them. We hope this will allow for reconstruction of large craniofacial defects.

Your major finding?
The major finding was that although calcium phosphate (CaP) scaffolds are great for new bone formation, they may slow down formation of blood vessels. Still, long, hollow, and functional blood capillaries can be 3D printed together with osteogenic CaP scaffolds for efficient vascularized bone regeneration.

The clinical importance?
Large bone defects in craniofacial reconstruction or implant therapy are difficult to heal and regenerate, primarily due to lack of vascular supply in the existing scaffold materials. With the technologies that we have been developing, we hope to overcome these barriers by 3D printing patient-specific osteogenic scaffolds together with the vasculature, thereby eliminating many of the existing problems in bone regeneration.

David Scott, PhD, University of Louisville School of Dentistry

Your topic?
Marijuana, oral bacteria, and periodontal disease

Your major finding?
Cannabis use predisposes individuals to destructive periodontal diseases. The underlying mechanisms may include phytocannabinoid-related microbial toxicity that could promote dysbiosis (a microbial imbalance) and a suppressed innate response to periodontal pathogens.

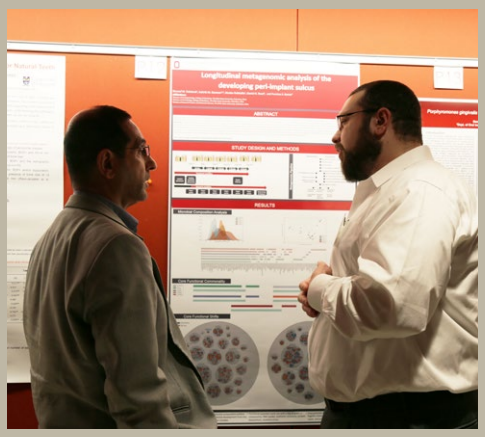
The clinical importance?
Oral health care professionals should contemplate the implications of marijuana consumption when considering patient education, prevention, and treatment.

Jerry (Jian Q.) Feng, MD, PHD
Assistant Dean for Research, Professor and Vice Chair Biomedical Sciences, Texas A&M College of Dentistry

Your topic?
Critical roles of periodontal ligament (PDL) cells in alveolar bone formation

Your major finding?
Our major findings are three-fold. First, PDL is the major bone cell resource for alveolar bone formation, which has much higher bone mineralization rates than from other bone cell sources, such as periosteum and bone marrow cells. Secondly, osteocytes, instead of osteoblasts, are the key cells in bone mineralization and there are severe defects in osteocytes obtained from periodontitis patients. And third, blocking sost, a potent inhibitor molecule released from osteocytes, restores the bone loss and PDL damages in periodontitis animal models *in vivo*.

The clinical importance?
In the future, anti-sost monoclonal antibodies can be used in restorations of bone losses and PDL defects in patients with severe periodontitis.



2nd Biennial Meeting of the IAAD

PENN DENTAL MEDICINE brought together leading international researchers and clinicians in the field of adhesive dentistry as hosts of the 2nd Biennial Meeting of the International Academy for Adhesive Dentistry (IAAD), held June 16–17. This two-day event, titled "Just bond it!," was developed under the leadership of Dr. Markus Blatz, Professor and Chair of Preventive & Restorative Sciences at Penn Dental Medicine, and the current IAAD President.

"Dental adhesion, in simplified terms, "bonding", along with new digital and CAD/CAM technologies, has literally transformed restorative dentistry. It allows us to be less invasive and apply the most esthetic materials, many of which rely on proper bonding techniques to function in the oral cavity," says Dr. Blatz. "The IAAD is an international platform for connecting relevant research with excellent clinical care in adhesive dentistry. This philosophy was the main driver for the meeting."

The "Just bond it!" program featured a roster of international speakers on a variety of topics within adhesive dentistry, poster sessions on current research, and a corporate scientific forum. In addition, there was an IAAD-sponsored consensus conference on the topic of restoration of endodontically treated teeth. Concurrently, a pre-conference hands-on course was presented by Dr. Simone Deliperi (Sardinia, Italy) on anterior and posterior composite-resin restorations.

"This hands-on course gave participants an opportunity to learn sophisticated techniques directly from one of the great masters," notes Dr. Blatz. It was held in the School's new state-of-the-art preclinical simulation laboratory.

The main program, which stretched over two days, was structured to showcase the wide field of adhesive dentistry from micro-invasive bonding techniques to dental laboratory protocols for indirect bonded restorations.

The poster sessions were an integral part of the meeting, with 29 poster presentations in the categories of students, junior researchers, and clinician faculty. First through third place awards were presented in each category (see page 41 for highlights of top awardees in each).

Abstracts of all the posters presented are available at the IAAD web site, *www.adhesivedentistry.org*. Abstracts and outcomes of the consensus conference on the restoration of endodontically treated teeth will also be featured in an upcoming special issue of the *Journal of Adhesive Dentistry*.

The next IAAD meeting will be held in 2019 in Bologna, Italy. "Penn Dental Medicine faculty will again play a lead role in the organization of this event, and in turn, in the progression of modern-day dental concepts and techniques around the world," says Dr. Blatz.

IAAD RESEARCH AWARD HIGHLIGHTS

The research poster presentations at the IAAD meeting were judged in three award categories; following are highlights of the studies that took first place in each.

Presidential IAAD Student Scientist Award 1st Place

Influence of a Novel Self-Priming Etchant on Bond-Strength to Glass-Ceramics

Haifa Alsobiyl, Abdulrahman Alshabib, Neimar Sartori, Sillas Duarte, Jin-Ho Phark
Ostrow School of Dentistry of University of Southern California

This presentation reported on a laboratory study that evaluated the influence of a novel self-priming ceramic etchant on micro-tensile bond strength (×TBS) to leucite reinforced glass-ceramic and lithium-disilicate reinforced glass-ceramic. CAD/CAM samples were fabricated from lithium disilicate reinforced glass-ceramic (IPS e.max CAD, Ivoclar Vivadent) and leucite reinforced glass-ceramic (IPS Empress CAD, Ivoclar Vivadent). Different surface treatment methods and materials were employed to test bond strength of dual cure resin cement (RelyX Ultimate, 3M ESPE) after treatment with a novel self-priming etchant to these materials before and after 6 months of water storage. Bond strength values varied from 0 to almost 50 MPs based on the type of pretreatment applied. The major finding was that long-term efficacy of a novel self-priming ceramic primer is highly variable among the two ceramic materials tested and dependent on the ceramics' composition and structural arrangement. Since these materials are used in private practice, understanding the performance of different ceramic primers and bonding agents is of fundamental importance.

Fusayama IAAD Junior Scientist Award 1st Place

Bioactive Rechargeable Dental Adhesive Based on Calcium Phosphate Nanoparticles to Inhibit Demineralization

Mary Anne Sampaio De Melo[a], Xianju Xie[b], Dan Xing[c], Michael D. Weir[a], Mark Reynolds[a], Yuxing Bai[b], Hockin Xu[a]
[a] University of Maryland School of Dentisty
[b] Capital Medical University School of Stomatology, Beijing
[c] China Rehabilitation Research Center, Beijing, China

Bioactive dental adhesives are attractive biomaterials for various applications in dentistry, for example, in orthodontics to inhibit white-spot lesions (WSL) in enamel. This presentation reported on a study of a novel rechargeable dental adhesive containing nanoparticles of amorphous calcium phosphate that allow calcium and phosphate ion release, recharge, and durable re-release capabilities to enhance tooth structure remineralization and inhibit demineralization. The novel adhesive had substantial Ca and P ion release, recharge and long-term re-release, while possessing good bond strength to enamel, suitable for orthodontic use to inhibit enamel demineralization and WSL. These findings are quite important and with high clinical relevance as the novel rechargeable adhesives are promising for orthodontics, crown cements, cavity liners, varnishes and composites, and other preventive and restorative applications.

IAAD Clinician Award 1st Place

Direct Flowable Restorations Utilizing Injection Technique: The Digital Approach

Saro Atam, Markus B. Blatz, Eva Anadioti, Julian Conejo
University of Pennsylvania School of Dental Medicine

This presentation described the clinical application of a composite injection to create direct composite veneers as definitive restorations. An innovative approach of combining digital technology and injection technique was used to treat malpositioned lateral incisors. After obtaining medical and dental history, clinical examination, diagnostic intraoral scanning with Cerec (Sirona) and photographs were obtained to provide data for diagnosis and treatment planning, which included four anterior composite veneers on teeth #7,8,9, and 10. A 3D printed model was fabricated after digital smile design analysis and digital wax-up. A clear vinyl polysiloxane material was used to create the transparent injection matrix. After minimal tooth preparation, etching, and bonding, flowable resin composite was injected through the transparent matrix and light-cured with the matrix in place. Each tooth was bonded separately and, after excess removal, refined and polished. The direct flowable composite technique is minimally invasive, time-efficient, and cost-effective. When combined with digital technology, the results are predictable and the process is more efficient than when combined with conventional techniques.

TOP, RIGHT: (left to right) Incoming IAAD president Dr. Lorenzo Breschi, current president Dr. Markus Blatz, and past president Dr. Jean-Francois Roulet.

Research Day 2017 Celebrates Faculty, Student Research

PENN DENTAL MEDICINE brought faculty and students together to share their research activities with one another and spotlight the depth of the School's research enterprise at Research Day 2017, held May 11 at the School. This was the second year for a combined student and faculty research event, designed to showcase the research being conducted throughout the Penn Dental Medicine community.

"Penn Dental Medicine Research Day now embraces all aspects and levels of research activities in the School, highlighting the great work of our faculty, junior researchers, and students," says Dr. Hyun (Michel) Koo, Chair of Penn Dental Medicine Research Day 2017. "It provides a forum for us all to learn more about each other's work."

The day's program included seven faculty presentations and two invited keynote speakers, along with a poster session what include 122 posters representing student as well as faculty/junior investigator projects.

Presenting faculty highlighted recently published research in both the basic and clinical sciences. Topics ranged from findings on the impact of diabetes on the oral microbiome (by Dr. Dana Graves, Dept. of Periodontics) and the role of the yeast-bacteria interaction in early childhood caries biofilm (by Dr. Geelsu Hwang, Dept. of Orthodontics) to a study on a receptor protein that may provide new approaches to inflammatory diseases (by Dr. Hydar Ali, Dept. of Pathology) and another on linking mechanical strain to neuroinflammation (by Dr. Claire Mitchell, Dept. of Anatomy & Cell Biology).

In other faculty presentations, Dr. Henry Daniell, Dept. of Biochemistry, talked on his work using a novel drug delivery approach, sharing that biopharmaceuticals can be delivered topically in chewing gum. The chewing gum, he explained, is impregnated with enzymes and antimicrobial peptides that are produced in plant cells to disrupt biofilms that form on teeth. In addition, Dr. Shuying (Sheri) Yang, Dept. of Anatomy & Cell Biology, discussed the discovery in her lab of a new bone protein (regulator of G protein signaling protein 12) that plays a key role in osteoporosis and inflammation-caused bone loss; and Dr. Chider Chen, also in the Dept. of Anatomy & Cell Biology, reported on findings that mesenchymal stem cell therapy can effectively rescue osteopenia and skin fibrosis in systemic sclerosis.

The day's keynote lecturers included Dr. Kam W. Leong, Samuel Y. Sheng Professor of Biomedical Engineering at Columbia University, speaking on the topic of "Bioengineering of Direct Cellular Reprogramming," and Dr. Martha Somerman, Director of the NIH's National Institute of Dental and Craniofacial Research, presenting the Joseph L. Rabinowitz Memorial Lecture on "NIDCR: Leading Advances in Oral Health Research and Innovation."

"I thoroughly enjoyed my visit to Penn Dental Medicine Research Day, which provided an opportunity for me to engage with faculty at the school and the broader campus," says Dr. Somerman. "The quality of research presented by the students was impressive, as is the vision set forth for the school by the leadership team."

A strong representation of the current research throughout the School was featured in the poster presentations, which along with 44 faculty/junior researcher posters, included 78 student projects from the Summer Research Program, the School's honors programs, the Bridging the Gaps community-internship program, and other independent student research. A faculty panel judged the student posters, presenting the Vernon Brightman Research Society Awards in first through third-place (see page 43). In addition, student and postdoctoral/young investigator research was also recognized with the awarding of the 2017 AADR Travel Grants; this year 10 DMD students and 12 individuals representing Master of Science in Oral Biology and Doctor of Science in Dentistry residents and junior investigators received Travel Grant awards. The AADR Travel Grant program was launched by Penn

Dental Medicine in 2014 to build opportunities to advance ongoing research and leadership among students and junior researchers; this year's recipients will attend and be encouraged to present their work at the 2108 AADR/CADR Annual Meeting to be held in Fort Lauderdale, Fla., in March 21-24, 2018. The 2017 Joseph and Josephine Rabinowitz Award for Excellence in Research was also presented to faculty (see page 43).

An event like Research Day can help advance research within the School in a number of ways, notes Dr. Dana Graves, Vice Dean for Research and Scholarship. "Research Day is a wonderful opportunity for researchers from different disciplines to share what they are doing and learn from each other," says Dr. Graves. "It allows students, basic research faculty, and clinical faculty to appreciate the accomplishments of each. It's a great day of exchange."

Research Day 2018 will be held Thursday, May 10, leading into Alumni Weekend 2018, May 11–12. "We encourage alumni to join us," adds Dr. Koo. "It is a unique opportunity to interact with faculty and students and hear about the research at Penn Dental." ■

VERNON BRIGHTMAN SOCIETY RESEARCH AWARDS

Following are highlights of the student research projects that received the Vernon Brightman Society Research Awards at Research Day 2017.

CBCT Assessment of Pubertal Growth Using Staging Methods in Orthodontics

Hassan M. Khan (D'18) was awarded first place for this study, conducted with preceptor Dr. Mel Mupparapu, Dept. of Oral Medicine

Assessment of pubertal and skeletal growth can play a pivotal role in assisting in timely orthodontic treatment. In his study, Hassan looked at three potential growth/development biomarkers to compare their reliability and validity. The study examined the spheno-occipital synchondrosis, mandibular third molars, and cervical vertebrae using the 5-stage method, Demirjian method, and Cervical Vertebral Maturation Staging (CVMS) methods for prediction of pubertal growth using CBCT data sets. They found that the CVMS correlated most closely with pubertal growth and appears to be the best way to determine skeletal growth.

Changes in RPE Peroxisome Lipid Metabolism in Response to Light Onset

Jennifer A. Caughey (D'19) was awarded second place for this study, conducted with preceptors Dr. Kathleen Boesze-Battaglia and Lauren Daniel, Dept. of Biochemistry

Jennifer's research project was focused on evaluating the peroxisomal metabolism of cells found within the Retinal Pigment Epithelium (RPE) — a supportive layer of epithelium that faces the retina within the eye. It was found that there is a diurnal regulation of this metabolic pathway based on an increase in peroxisome function in the morning when compared to the afternoon. RPE cells are vital for healthy eye function, and a better understanding of this metabolic pathway can help assist in the treatment of degenerative eye diseases.

A Content Analytic Approach to Assessing Triggers of Dental Anxiety

Hallie Klein (D'19) was awarded third place for this study, conducted with preceptor Dr. Joan Gluch, Div. of Community Oral Health

In her research project, Hallie developed the Dental Anxiety Triggers Scale (DATS) based on reports from Penn Dental Medicine patients and found it to be an equally good measure of dental anxiety as the most widely used dental anxiety scale, the Modified Dental Anxiety Scale. However, the DATS has the advantage of being rooted in real patient experiences, not researcher intuitions. Because the DATS provides more concrete examples of triggers, it may be useful for dental practitioners who want to be sensitive to their patients' anxiety.

OTHER STUDENT AWARDS

2018 AADR Dentsply Sirona SCADA: Selected on Research Day to represent Penn Dental Medicine in the 2018 AADR Dentsply Sirona Student Competition for Advancing Dental Research (SCADA) program was Abby Syverson (D'19) for her research honors project titled "Lineage Specific NF-KB Inhibition in MSCs Resolves Lymphocyte Trafficking in Diabetic Fractures," conducted with preceptor Dr. Dana Graves, Dept. of Periodontics. She will present her research at the 2018 AADR/CADR Annual Meeting in Fort Lauderdale, Fla, March 21–24, 2018

Radiology Honors: Students in the radiological sciences honors program also were recognized with awards for their joint projects — *1st place:* Thomas Yoo (D'18) and Minou Luo (D'18); *2nd place:* Heliya Ziai (D'17), Aaron Ivanhoe (D'17), Jon Shue (C'17) and Corey Toscano (D'17); and *3rd place:* Sara Gholam (D'17) and JV Cracke (D'17).

RABINOWITZ AWARD

The Joseph and Josephine Rabinowitz Award for Excellence in Research is presented annually to Penn Dental Medicine investigators. The endowed award was established by the Rabinowitz family in 2002 to support and encourage independent research. This year's award recipients, presented at Research Day 2017 include:

Dr. Sunday Akintoye, Associate Professor, Dept. of Oral Medicine

Radiation therapy for head and neck cancers can lead to the complication of jaw osteoradionecrosis. Dr. Akintoye's lab will explore the application of mesenchymal stem cells and osteoanabolic therapy for prevention and remediation of osteoradionecrosis.

Dr. Bei Zhang, Postdoctoral Fellow, Dept. of Biochemistry

Dr. Zhang will work on a project that focuses of the expression of human coagulation factors in edible plant chloroplasts for treatment of life-threatening bleeding disorders and evaluation of post-translational modifications. This approach offers noninvasive drug delivery and eliminates the immunogenic side effects of clotting actors currently used in the clinic.

Penn Stem Cell and Regenerative Dentistry Conference

AT PRESS TIME for this issue of the P*enn Dental Medicine Journal*, Penn Dental Medicine was about to host the inaugural Penn Stem Cell and Regenerative Dentistry Conference. Held October 20 – 21, the event brought together researchers and clinicians at the forefront of investigating dental stem cells and stem cell-based therapies.

The two-day program featured the state-of-the-art in dental stem cell research and the potential translational clinical applications. Along with Penn Dental Medicine faculty who are actively engaged in stem cell research, the program of speakers represented 10 other universities from across the country as well the United Kingdom and China. A poster session and junior investigator presentations supplemented the program.

"Dental stem cell application represents the future of bio-dental therapies."

— DR. SONGTAO SHI

Topics addressed by Penn Dental Medicine faculty highlighted key aspects of their ongoing research, including the following:

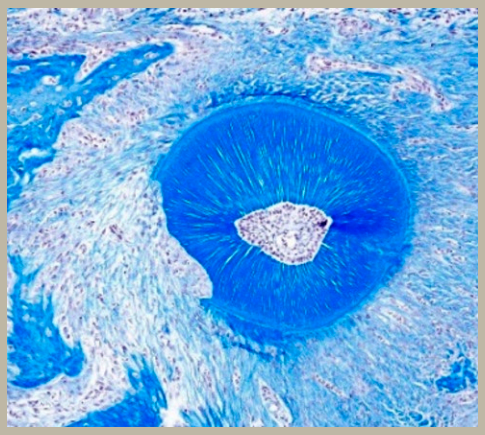
- peripheral nerve regeneration with orofacial stem cells by Dr. Anh Le (Dept. of Oral & Maxillofacial Surgery),
- bone regeneration by Dr. Shuying (Sheri) Yang (Dept. of Anatomy & Cell Biology),
- regenerative endodontic procedures by Dr. Su-min Lee (Dept. of Endodontics)
- dental stem cells in tissue regeneration by Dr. Songtao Shi (Dept. of Anatomy & Cell Biology).

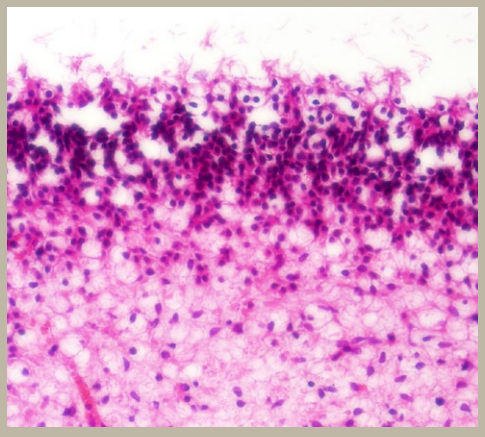
Dr. Songtao Shi, Chair and Professor, Department of Anatomy & Cell Biology and one of the conference organizers, noted that dental stem cell-based therapies have been initiated in clinical trials, including for dental pulp and periodontal tissue regeneration. "Dental stem cell application represents the future of bio-dental therapies," he says.

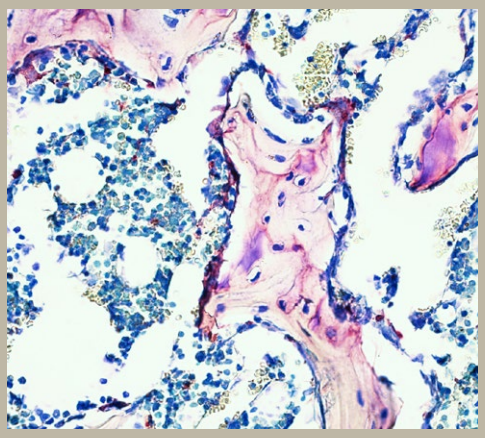
Other presentations and discussions ranged from stem cell therapies for autoimmune diseases, to the use of stem cells to make dentin.

The keynote address, titled "Overcoming Chromatin Barriers to Change Cell Fate," was presented by Dr. Kenneth S. Zaret, Director of Penn's Institute for Regenerative Medicine (IRM), which engages scientists, clinicians, and ethicists from medicine, engineering, veterinary sciences, dental medicine, and the arts and sciences.

"We are using the principles learned from the natural processes to generate new cells and tissue fragments in the laboratory and to control tissue regeneration in the body," he says of IRM's goal overall. "Our work is aimed to model and study human diseases, to develop new diagnostics and medicines, and, ultimately, to replace damaged, aged, or diseased body parts."







Organizing the conference from Penn Dental Medicine were Dr. Bekir Karabucak, Chair and Associate Professor of Endodontics; Dr. Syngcuk Kim, Louis I. Grossman Professor, Department of Endodontics; and Dr. Songtao Shi, Chair and Professor, Department of Anatomy & Cell Biology.