Anyone involved with dentistry today knows that the profession and the science behind it are advancing more rapidly than ever before. The Ostrow School of Dentistry of USC, part of one of the nation’s top research universities, is set apart from other dental institutions in how we are committed not only to excellence in dental education but also to remaining at the forefront of scientific investigation.

From developing new dental techniques and materials to understanding the intricacies of oral, facial, and cranial development, everything our researchers do is intimately connected to clinical practice and improving patients’ lives. This is a natural product of having many faculty members who are trained in both clinical practice and conducting research. Successfully translating our research into clinical applications is also facilitated by frequent and productive multidisciplinary collaborations with USC peers and outside colleagues in medicine, engineering, and more from around the nation and the world.

Many of our faculty members are world-renowned for their groundbreaking research, high-impact publications, funding success, awards, and leadership positions at national and international levels. But the Ostrow research community has also made a name for itself for the unique training opportunities it offers to students and young researchers starting their scientific careers. Alumni of our graduate programs and postdoctoral fellowships have gone on to become influential, award-winning scientists and leaders of elite academic and research organizations.

The Ostrow research environment also has an important effect on students working toward a career in clinical practice. Students participating in research get a firsthand look at upcoming developments in the profession, one-on-one interaction and mentorship from faculty members, and develop a love for learning and critical thinking that will stay with them for life.

Read on to learn more about five of the many Ostrow investigators, their work, and what participating in research means to them.
Dentistry is a family tradition for Ronald Chung, a third-year DDS student who grew up visiting his parents’ dental practice and talking about the profession over dinner. Since he learned about Ostrow firsthand from his Trojan dentist family members, he knew he’d have many opportunities to maximize his own education.

“When I came to dental school, I thought I would really take ownership of my education and not only get a good clinical education but also reach out and do other things,” Chung says.

Under the mentorship of Professor Yang Chai, Ph.D. ’91, DDS ’96, Chung began investigating transforming growth factor beta (TGF-β), a protein with many important functions in embryonic development, and its role in lower-jaw growth. When one of the major cell signaling pathways of TGF-β was disrupted by a mutation, specific parts of the mandibles of affected mice failed to form properly, Chung says.

However, when an alternative pathway for TGF-β was activated in another group of mice with the same mutation, the jawbone’s formation was partially restored.

 “[The mandible] doesn’t grow exactly the same way to the same size, but it shows similar features and grows back almost 90 percent,” Chung says. The long-term hope is that finding similarly redundant cell signaling pathways for TGF-β in humans will provide non-surgical, prenatal treatment options for mouth and face deformities, he adds.

In addition to his work with TGF-β, Chung and fellow student Peter Lee, DDS ’13 worked with Assistant Professor Parish Sedghizadeh to study bisphosphonate-related osteonecrosis of the jaw, or BRONJ. The disease is characterized by the unexplained death of jawbone tissue in patients who have taken bisphosphonates, drugs used frequently for osteoporosis.

Using data from BRONJ patients, Chung and Lee built a model that connected the length of bisphosphonate treatment, patient body mass, and amount of bisphosphonate present in patients’ plasma and bone to determine the toxic threshold, at which point the level of bisphosphonate present becomes likely to cause BRONJ.

“Our conclusion is BRONJ has everything to do with the duration of bisphosphonate therapy,” he says. “People are accumulating this in their bodies.”

The project was lauded as the best clinical science project conducted by DDS students at Ostrow’s 2013 Research Day.

Chung not only presented both projects at Research Day but also helped plan the event as president of Ostrow’s Student Research Group. He also was editor-in-chief of the Explorer, an award-winning annual research magazine created entirely by students.

Chung’s dream is to become an orthodontist and go into private practice, but he emphasizes how conducting research has enriched his education and perspective.

“With research I feel like I’m getting a very holistic education,” he says.

Check out highlights from this year’s Research Day in the award-winning Explorer: tinyurl.com/explorer2013

Ronald Chung

BY BETH NEWCOMB MPH ’13
Chloe Cohen, a third-year periodontology resident and craniofacial biology master’s student, knew from an early age she wanted to pursue dentistry, but she didn’t know it would lead her to experience dental research as well.

Cohen became interested in dentistry when she received orthodontics as a child, and she worked for her orthodontist in high school to learn more. Keeping the Ostrow School of Dentistry’s reputation for high clinical standards in mind, she completed her undergraduate degree at USC before being accepted into the school’s DDS program.

“USC had an amazing reputation for their dental school, and I wanted to be the best,” she says.

During dental school, her experiences shadowing a periodontist led her to fall in love with surgery and periodontology, and she began her advanced periodontology residency at USC following graduation. She simultaneously began work on a master’s in craniofacial biology, which launched her interest in research. Now, Cohen has worked on two projects that have given her valuable experience in both laboratory and clinical research.

Under the guidance of Professor Jorgen Slots, Cohen began investigating the bacteria in dental plaque of otherwise healthy adults with untreated periodontal disease, comparing the types of bacteria found beneath and above the gum tissue.

As predicted, the bacteria populations above and below the gumline were different. “We’re also finding interesting things like a new aerobic bacteria that is subgingival, which is really unusual,” she says, adding that the project’s next step is to repeat the analysis with samples from patients after treatment.

Cohen’s other project, conducted with Associate Professor and Advanced Periodontology Residency Program Director Homa Zadeh DDS ‘87, examines the efficacy of a new, simpler technique for connective tissue grafting developed by Zadeh.

The technique, Vestibular Incision Subperiosteal Tunnel Access (VISTA), is a less invasive alternative to traditional surgical treatment for receding gums that uses a single incision above the gumline and an innovative suturing technique to secure the gum tissue properly over the root.

The root coverage results are similar, and in some cases better, than the traditional method, Cohen says. Her project regarding VISTA’s effectiveness was named Most Innovative by the USC Stevens Center for Innovation during Ostrow’s 2013 Research Day.

“I get to see the results firsthand with my patients,” she says. “[The intrasulcular method] is very difficult, and a lot of things can go wrong. VISTA is straightforward, simple to do, and reduces chair time.”

While Cohen is still aiming for the clinic after graduation, she’s also thinking about staying involved with research and education, perhaps as a part-time faculty member.

“I want to work in private practice, but I also want to stay close to academics because you can never learn enough,” Cohen says. “I still have questions. If you don’t have questions, that’s when you should be worried!”
Associate Professor Sillas Duarte Jr. is busy at Ostrow, balancing his roles as chair of the Division of Restorative Sciences and director of the Advanced Operative Dentistry Program with his research. He’s happy to use his clinical and teaching skills with his research expertise in his work at USC, since he says the combination has helped him “discover new ways of seeing things” throughout his career.

Originally from Brazil, Duarte received his DDS from São Paulo State University at Araraquara. During his sophomore year in dental school, he got involved with research for the first time, and he was inspired to combine his clinical knowledge and skills with a strong scientific background as he began his dental career. As he treated patients in private practice, he completed a fellowship and certificate in operative dentistry as well as a Ph.D. in biomaterials. He continued to research dental materials and restorative techniques upon relocating to the United States, and he arrived at USC in 2011.

Duarte’s current research is directed at determining which methods improve the retention and longevity of dental restorations. “Any material we use to restore your tooth is highly affected by moisture, fluids, and water,” he says. “My focus is how we can improve bonding and delay the degradation of the bonded interface.”

He says the three main aims of his work are increasing a dental restoration’s longevity, understanding the behavior and aesthetics of the biomaterials used in restorations, and improving the interactions between restorative materials and the natural tooth structure. His latest project compares different materials not only by noting their outward appearance and characteristics but also by analyzing reconstructions of the adhesive interfaces of restored teeth. Detailed three-dimensional images, produced by slicing a tooth into hundreds of nanometer-thin sections and scanning them, reveal precisely where weak spots in the adhesion between the restorative material and natural tooth have begun to form.

Duarte says Ostrow is a great place for his research due to its long legacy of clinical excellence and innovation and the ability to interact with high-end clinicians. He adds the research environment at USC is very forward thinking, which is critical for a profession that is changing faster than ever. “New products and techniques hit the market every six months,” he says, emphasizing the great need for evidence dental practitioners can use to make good clinical decisions.

Ostrow’s constant presence at the forefront of dental science also makes it a great educational institution, he adds. The Operative Dentistry Program—the only one of its kind on the West Coast—not only offers its residents excellent clinical training complete with the latest information and technology but also the opportunity to conduct research, as each resident also completes an MS in Craniofacial Biology.

“Residents are exposed to a completely different level of understanding of the profession,” by participating in research, Duarte says.
Assistant Professor Amy Merrill-Brugger Ph.D. ’05 is trained in both human genetics and developmental biology, and she’s using her multifaceted expertise to unlock the mysteries of how genes direct bones to grow during embryonic development.

A science enthusiast since childhood, Merrill-Brugger began conducting research as an undergraduate at UCSB studying molecular, cellular, and developmental biology. She pursued graduate studies, arriving at USC for the first time as a Ph.D. student in biochemistry and molecular biology at the Keck School of Medicine. During that time, she began exploring craniofacial development and birth defects, which has influenced her work ever since.

“Our face is our window to the world, so these birth defects are particularly devastating,” she says.

Merrill-Brugger went on to do a postdoctoral fellowship at UCSF, where she studied the timing of bone formation. Many birth defects involve formation of bone that’s either too early or too late, she explains.

She also completed postdoctoral training at UCLA and Cedars-Sinai Medical Center, focusing on the discovery of gene mutations responsible for skeletal birth defects. She says the experience was “incredibly rewarding.”

“I could see my research was directly impacting the families we were working with,” she says. “By identifying the disease genes for disorders without a molecular diagnosis, we immediately give the families an option for prenatal diagnosis.”

Merrill-Brugger joined Ostrow’s Center for Craniofacial Molecular Biology (CCMB) as a faculty member in 2010, taking her research to the next step of identifying precisely what genes connected to disorders do to regulate the shape and timing of bone growth during embryonic development. She hopes to use the information to devise new strategies for bone regeneration and repair, which has huge clinical implications, she says.

“Five percent of all children are born with craniofacial defects that affect the underlying bone,” she says. “Most of us will also face the challenges of poor bone health as we age. We hope the information we glean from skeletal birth defects will also allow us to repair adult bones injured through disease or trauma.”

Her dual appointment in Ostrow and Keck was supported by a prestigious P30 grant from the National Institutes of Health designed to support promising new faculty. She says returning to USC as faculty and joining CCMB was like returning home.

“CCMB is a world leader in the field of craniofacial development and regeneration,” Merrill-Brugger says. “To be a member in this group of highly successful researchers is an honor.”

Her multidisciplinary background and dual faculty appointment give her many great opportunities for networking and collaboration with her USC colleagues.

“It’s nice to have this wonderful network of scientists around you,” she says. “USC is unique in that the faculty are so tightly knit. There’s a wonderful sense of community.”
Professor Michael Paine PERIO ’99 is not only researching how the human body forms tooth enamel, he’s also influencing the next generation of craniofacial biology scientists and science-minded clinicians as director of the USC Craniofacial Biology Graduate Program.

A native of Australia, Paine studied biochemistry before attending dental school at the University of Sydney. While he “enjoyed the clinical component of dentistry,” he says he was particularly inspired by one of his third-year pathology professors, and after practicing dentistry, he returned to school to obtain a Ph.D. in pathology.

He came to the U.S. for postdoctoral work, and he eventually began working with Professor Malcolm Snead of the Ostrow School of Dentistry Center for Craniofacial Molecular Biology (CCMB). Paine has remained at Ostrow ever since, fulfilling his postdoctoral fellowship, completing a periodontology residency, becoming a tenured faculty member at CCMB, and leading the graduate programs in craniofacial biology.

His research has focused on the delicate processes that surround the creation of tooth enamel—the human body’s hardest substance when properly formed.

“The research [Snead] was doing was on enamel formation and biomineralization, particularly how the enamel matrix proteins interact with each other,” Paine says. “I worked on a project with him, and now 20 years later I’m still here playing with that same sort of theme.”

Tooth enamel forms during development as ameloblast cells and enamel matrix proteins on developing teeth interact, depositing and arranging minerals that make up the finished enamel. After the enamel is formed, the matrix of proteins is removed.

The enamel formation process can go awry, as seen in the disorder amelogenesis imperfecta. Currently, one aspect that Paine and his collaborators are focused on is the role of proper ion transport and pH control within the enamel matrix. Mutations in certain genes for proteins that control pH and ion movement have now been connected to improper enamel formation, he says.

“If you can identify the processes fundamental to tooth formation, then you have many opportunities to find out how these activities can go wrong,” he says.

In addition to the discoveries he’s made with his research, he’s helped many Ostrow students through his leadership of the school’s graduate programs.

In 2011, Paine was awarded a prestigious five-year T90 training grant from the National Institutes of Health, which provides funding for tuition, stipends, travel, and more to Ph.D. students and postdoctoral trainees at Ostrow each year. The grant adds to an already attractive research setting for both new and seasoned researchers, he says.

“USC, Ostrow, and CCMB have a thriving, protective research environment with junior and senior investigators working together,” Paine says. “We have a great reputation, a strong research profile, and we do particularly well year after year with funding, publications, and research.”