Evolution of the Scientific Basis for Dentistry and Its Impact on Dental Education: Past, Present, and Future

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Abstract: Science is the fuel for technology and the foundation for understanding the human condition. In dental education, as in all health professions, science informs a basic understanding of development, is essential to understand the structure and function of biological systems, and is prerequisite to understand and perform diagnostics, therapeutics, and clinical outcomes in the treatment of diseases and disorders. During the last seventy-five years, biomedical science has transformed from discipline-based scientists working on a problem to multidisciplinary research teams working to solve complex problems of significance to the larger society. Over these years, we witnessed the convergence of the biological and digital revolutions with clinical health care in medical, dental, pharmacy, nursing, and allied health care professional education. Biomedical science informs our understanding, from human genes and their functions to populations, health disparities, and the biosphere. Science is a “way of knowing,” an international enterprise, a prerequisite for the health professions, and a calling and adventure to the curious mind. Science, the activity of doing science, is in the national self-interest, in the defense of a nation, and critical to the improvement of the human condition. In the words of Vannevar Bush, “science is the endless frontier.”

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The achievements of dental education have advanced within a broad cultural context. For the United States through the last half of the nineteenth century and through most of the twentieth century, those achievements were indirectly shaped by the nation’s ambitions for growth, economic prosperity, higher education, science and technology, and immigration policies. During the last seventy-five years, our economic expansion, growth, and innovations have profoundly influenced our culture—within governmental agencies, universities, academic health science centers, foundations, professions, and industry. Science and technology, in the form of research and development, have been enthusiastically supported and in turn have transformed all aspects of our human condition. It is within and as a consequence of these multiple advances that university-based dental education and science have emerged.

Within this context, I encourage the reader to consider that science and scientific activity are not isolated to a specific profession, a school, or a specific government agency or industry. Rather, science and scientific activities—physical, chemical, biological, and behavioral scientific inquiry—take place within a larger matrix that also includes political, social, and economic influences, along with concurrent developments in the “ways of knowing” in the arts, philosophy, and technology. This is particularly true for the sciences and their linkages, interconnections, and impact on the emergence of dental education, science, and clinical practice over the last seventy-five years.14 In this contribution to the seventy-fifth anniversary issue of the Journal of Dental Education, aligned with the prominence of the American Dental Education Association (ADEA), I will offer highlights that illustrate the major drivers of science in dental education, major accomplishments, major game changers, a selected group of individuals who show the profound impact of science and science activity on dental education, and a prospectus for the remaining twenty-first century with highlights of opportunities and challenges.

Major Drivers of Science in Dental Education

Roadmap from the Gies Report

Early in the twentieth century, the Carnegie Foundation for the Advancement of Teaching, located in New York City, funded a series of reports on professional education in the United States and Canada. The fourth report, Abraham Flexner’s 1910 study of
medical education, provided a blueprint for the future of predoctoral medical education that continues today. The Flexner report continues to shape medical education: an emphasis on innovations in education, an awareness of conflict of interest between proprietary interests versus those of the university, an encouragement to align medical education with parent research-intensive universities, the creation of and advocacy for higher standards for medical school admissions, recruitment and retention of well-qualified, full-time faculty, and, finally, advocacy for medical education grounded in science and scientific activity in research and thinking.

The tenth Carnegie report, written by William Gies and consisting of 250 pages of text and 400 pages of appendices, was published in 1926. Within the social context of that time, like the earlier Flexner report, the Gies report made five recommendations: 1) within universities, dental education should be perceived and supported like medical education; 2) teaching and research in dental schools should be as effectual as the best in the university and the status of the dental faculty should be raised accordingly; 3) the preparatory education and admissions requirements for dental education should be identical to those for medical education; 4) the dental curriculum should result in a general practitioner within three years; and 5) dental education should provide an optional full-year graduate curriculum, separate or combined, including dispensary and hospital experience as well as opportunities and encouragement for research, and “should be provided for all types of specialization in oral science and art, especially those of practice, public health administration, teaching, and investigation.”

World War II and Its Effects

Out of the destructive force that characterized World War II, a number of constructive dividends emerged, including policies highlighting that science and technology are in the national defense interest (see The Endless Frontier by Vannevar Bush published in 1945). National policies were also established to provide post-secondary technical school and university education for the millions of returning military personnel through the G.I. Bill. Other dividends were significant advances in the treatment of trauma and infection, innovations for imaging such as those derived from sonography that led to ultrasound, and the national realization that healthy teeth are in the national defense interest.

The most influential architect for U.S. science policy during and following World War II was Vannevar Bush, an academic (professor, dean of engineering, and vice-president of MIT), engineer with many contributions to analog computing including anticipation of the World Wide Web, primary behind-the-scenes organizer of the Manhattan Project and the realization of the atomic bomb, founder of Raytheon and the idea of “memex,” and President Roosevelt’s and President Truman’s director of the Office of Scientific Research and Development. During the war, Bush coordinated the activities of 6,000 leading American scientists in the application of science to warfare.

Anticipating a future peace without war, Bush recommended to President Roosevelt in his transmittal letter of November 17, 1944, for his treatise “Science the Endless Frontier,” four questions regarding the postwar period:

1. What can be done, consistent with military security, and with the prior approval of the military authorities, to make known to the world as soon as possible the contributions which have been made during our war effort to scientific knowledge?

2. With particular reference to the war of science against disease, what can be done now to organize a program for continuing in the future the work which has been done in medicine and related sciences?

3. What can the Government do now and in the future to aid research activities by public and private organizations?

4. Can an effective program be proposed for discovering and developing scientific talent in American youth so that the continuing future of scientific research in this country may be assured on a level comparable to what has been done during the war?

These four questions resonate even in today’s world. It was evident to Roosevelt, Truman, Congress, and an array of government agencies, industry, and nonprofit organizations that our nation’s defense was directly coupled and aligned with “wars on diseases and disorders” (e.g., cancer, heart disease, dental caries, and mental diseases). Curiously, the use of the metaphor of “war” continues to haunt cur-
rent interpretations of scientific strategies to address birth defects, dental caries, cancers, cardiovascular diseases, ocular diseases, osteoporosis, pulmonary diseases, and periodontal diseases. The policies established during and following World War II continue to have enormous influences on biomedical sciences, behavioral sciences, and dental education.

Yet another dividend was the exodus of physical, chemical, biological, and behavioral scientists from Europe to the United States. This was particularly evident in the 1930s and early 1940s when a number of highly gifted dental scientists fled Germany and Austria and relocated in dental schools in Chicago at either Loyola University or the University of Illinois, while others moved to Baylor University in Texas. Some of this extraordinary talent for dental science (embryology, anatomy, histology, histopathology, oral medicine) and education included Bernard Gottlieb, Balint Orban, Rudolf Kronfeld, Harry Sicher, and Joseph Peter Weinman. Following the war, immigration policies enabled scientific talents from all over the world to relocate within the United States, and these policies have influenced all of the health professions schools and their parent universities.

Creation of the NIDR (1948) and NIDCR (1998)

Vannevar Bush’s efforts influenced all of the government agencies associated with science and technology. By June 1948, his blueprint for the National Institutes of Health (NIH) included three institutes—Cancer, Dental, and Heart, the first three to comprise the NIH. In addition to Bush, organized dentistry, dental educators, and several members of Congress aligned their interests and were very successful advocates for the realization of the NIDR, signed into law by President Truman on June 26, 1948. In keeping with the spirit and intent of Bush’s “Science the Endless Frontier,” the three new NIH institutes rapidly were authorized to advance three key goals: 1) create an intramural scientific research infrastructure at the NIH Campus in Bethesda, Maryland; 2) create extramural grant-giving programs aligned with peer review through study sections; and 3) create training programs, intramural as well as extramural, supported by federal as well as non-profit professional organization funds, such as the American Dental Association (ADA), American Medical Association (AMA), and, more recently, Howard Hughes Medical Research. Graduate and postgraduate education and training programs, individual or institutional, enabled the creation of a national biomedical research community within the medical, dental, pharmacy, nursing, allied health professions, and/or graduate schools and within research institutes at the NIH.

The creation of the National Institute of Dental Research (NIDR) in 1948 was enormously instrumental in building science and technology within dental schools, as well as using science to inform the practice of oral health care. NIDR Directors Dean, Arnold, Kreshover, Scott, and Löe worked to advance dental sciences within the NIH, throughout North America, and beyond. In sequence, they grew the scope and breadth of the NIDR as it became the “beacon for international dental research.” In July 1995, I became the sixth director of the NIDR and served on the leadership team of NIH Director Harold Varmus. During that time, the pre-9/11 era, was the appropriate time to develop civilian applications for the World Wide Web, the Internet and Intranet, and to foster rapid communication within the biomedical scientific community. It was also the era of developing genetically defined, exquisite animal models for human diseases and disorders—from earth worms to fruit flies to genetically engineered mouse strains. In no small measure, my role was to continue the efforts established by my predecessors (strengthening both intramural and extramural scientific research programs while increasing efforts for training and building infrastructure). The political, social, and economic climate at that time also enabled the entire NIH to significantly increase each institute’s budget, essentially doubling the budget during my tenure from 1995 to 2000. In 1996, NIDR was invited by Secretary of Health and Human Services Donna Shalala to serve as the lead government agency for a proposed surgeon general’s report on oral health in America, the first such report of its kind. It was released and published in May 2000 under Surgeon General David Satcher. In addition, we worked closely with the ADA, ADEA, and the American and International Association for Dental Research (AADR/IADR) to change the name of the institute from NIDR to the National Institute of Dental and Craniofacial Research (NIDCR) upon its fiftieth anniversary in October 1998. The driver for the name change was the well-established depth and breadth of the institute’s research and training portfolio.

My tenure ended in June 2000, and Lawrence Tabak was appointed as the seventh director of now NIDCR that fall. Under his leadership, the NIDCR significantly increased translational and clinical re-
search, behavioral research, and an emphasis upon saliva as a diagnostic fluid. Tabak worked closely with dental educators and dental deans to build and sustain a national oral health infrastructure.\textsuperscript{12} One of his major accomplishments was the development of a dental practice-based research network (PBRN) in 2005.\textsuperscript{13-15} His tenure extended for ten years (2000–10), and he was followed by Martha Somerman, who started her tenure in fall 2011. A brief historical summary of the NIDR and NIDCR directors and their scientific accomplishments and impact on dental education can be found in publications written by Harris,\textsuperscript{8} Gutman,\textsuperscript{9} and Slavkin.\textsuperscript{10}

**Scientific Journals and Other Collaborations**

Many of us have discovered that “doing” science can often be an interdisciplinary effort requiring highly effective communication, cooperation, and collaboration. From the 1930s on, numerous clinicians and biomedical scientists aligned around shared interests in specific diseases or disorders (e.g., teratology, birth defects, cleft lip and palate, craniofacial malformations, tooth decay and related cariology, autism, child abuse, cancers, chronic facial pain, periodontal diseases, temporomandibular joint disorders, etc.) organized workshops, seminars, conferences, societies, and journals to enhance the research enterprise. Numerous peer-reviewed biomedical research journals were founded to rapidly communicate original scientific discoveries as well as critical reviews of emerging scientific activities. More recently, web-based publications have emerged to further enhance and accelerate domestic and international scientific communication, cooperation, and collaboration.

**University Departments of Dental Science and Oral and Craniofacial Biology**

From 1948 to the present, federal funding for biomedical research has essentially doubled every ten years. This is especially true when assessing the growth of the collective NIH institutes (presently there are twenty-seven, with total funding of over $30 billion per year).\textsuperscript{16} In this climate, dental schools were aligned with academic health centers at their parent universities and/or fostered the recruitment of faculty members with interests in biomedical research. In tandem, many new academic departments were created within dental schools and/or between dental and medical schools, to recruit and retain faculty and advance biomedical research programs. For example, dental materials evolved to a department of biomaterials to explore the design and fabrication of “bimimetics solutions” for an array of clinical conditions. This heralded the advent of “regenerative medicine/dentistry” and visions for remarkable innovations for cell, tissue, and organ regeneration.\textsuperscript{16-18}


Despite the Gies report, the G.I. Bill, Bush’s treatise and policies, the creation of the NIH with multiple institutes including the NIDR, and remarkable progress in our nation’s wealth and prosperity, all dental schools did not have the necessary infrastructure (human, physical, and administrative) to effectively foster and sustain a robust biomedical research program.\textsuperscript{19-22} Of the twenty-two recommendations of the Dental Education at the Crossroads report issued by the Institute of Medicine (IOM) in 1995, recommendations nine, ten, and eleven were that oral health care should be evidence-based with a foundation in research, that each dental school should build research capacity, and that U.S. dental schools should align with the NIH and other potential funders to sustain the biomedical research enterprise.\textsuperscript{23}

**Major Accomplishments**

Over the last seventy-five years, the scientific method and scientific inquiry profoundly impacted dental education and the preparation for oral health professionals. This phase in health professions education has been called a renaissance in terms of the depth, breadth, and rate of scientific discovery. Rather than provide a lengthy and detailed set of primary references and reviews, this article provides a few selected highlights of cases in which science has impacted dental education and clinical practice.

Starting from epidemiology, chemistry, and public health studies, for example, we learned about fluorosis as well as the benefits from water fluoridation and topically applied fluoride. We learned that tooth decay or dental caries are the result of opportunistic bacterial infections, transferred from the mother to the infant during childbirth and also transferred from the caregiver to the developing infant over the first three years of life. We learned about the microbial ecology of the mouth, biofilms, and the exquisite communication systems that are based in part on microbial
quorum sensing genes within the microbial genome. We learned about infection control, dental sealants, xylitol, toothbrush designs, and an array of dentifrices, mouthwashes, and dental flosses.

Further, we learned about chronic and destructive connective tissue disorders such as periodontal disease involving the periodontium including cementum, connective tissue molecules within the periodontal ligament (types I and III collagens, fibronectins, proteoglycans, hyaluronate, metalloproteases, and their cognate inhibitors), adjacent alveolar bone, bone turnover, proteases and protease inhibitors, toxins, and the host immune system. We discovered that oral infections are associated with systemic diseases and disorders such as low birth weight, premature babies, cardiovascular disease, and pulmonary diseases and disorders. We discovered the details within the oral microbial genomes of select pathogens including viral, bacterial, and yeast genomes. These discoveries further inform targeted therapeutic developments.

The discovery of the structure and suggested functions of deoxyribonucleic acid in 1953 rapidly led to the discovery of the genetic code, recombinant DNA technology, emerging biotechnology industries, the completion of the human genome, and microbial, animal, and plant genomes and introduced the post-genomic era with proteomes, transcriptomes, metabolomes, diseasomes, pharmacogenetics, and personalized medicine. Human genetics, gene-gene and gene-environment interactions, and relative risk factors for diseases and disorders became part of a modern oral health professional’s education. In tandem, we advanced from x-rays and radiographs to an array of imaging technology such as ultrasound, PET and CAT scans, cone-beam tomography, and MRI images. We now are enabled to see, plan, and think in three-dimensions. Imaging, principles, and applications have become part of dental education (and beyond).

Based on remarkable progress in cellular, molecular, and developmental biology, we now are able to consider biomimetic strategies—to design and fabricate cells, tissues, and organs—as a foundation for repair, healing, and regeneration. At the same time, the advances in the chemistry of adhesion have remarkably informed the improvements in dental restorative materials: porcelains, metals, and composite resins. The advances in the high-speed handpiece have been complemented by the electric handpiece. CAD-CAM technology has evolved from the science produced within the digital revolution and is transforming many aspects of operative and restorative dentistry: digital impressions and milling restorations, for example, while saving time and money. Collectively, science and scientific discoveries have informed dental education and have profoundly improved oral health care in the United States, Canada, and beyond.

Major Game Changers

Communication

The annual meetings of health and biomedical research professional organizations (e.g., ADA, ADEA, AADR, and IADR) have had a profound effect on scientific exchange through oral and poster presentations. Correspondingly, the annual Gordon Conferences held in New England, Santa Barbara and Ventura, California, and parts of Europe have served as catalysts for major communication among working scientists. Conferences, workshops, lectures, and seminars hosted by the NIH, universities, and dental schools have served to enhance communication. Beyond print media (books, journals, published reprints), conference calls, visual web-based conferences, webinars, blogs, and e-mail have profoundly influenced both domestic and international communication. This array of communication methods has greatly engaged dental school faculty members and full-time and part-time scientists and clinicians.

Cooperation

Enlightened self-interest continues to be a major motivational factor for increasing cooperation within academic environments. At the federal level, NIH-sponsored cooperative agreements provide a mechanism that fosters interdisciplinary cooperation between and among scientists working on complex problems such as the pathogenesis of diseases, molecular mechanisms that explain various types of therapy, regenerative medicine and dentistry using an array of biomimetics strategies, multicenter clinical trials, and so much more. The establishment of core facilities (e.g., genomics, proteomics, bioinformatics, biostatistics, and imaging) in universities and schools leverages resources and further fosters cooperation.

Collaboration

Following World War II, numerous federal and state agencies and professional organizations
put forth requests for proposals or applications that required interdisciplinary approaches to solving complex problems of significance to society. Increasingly, teams of biomedical and behavioral scientists were assembled to address complex problems such as autism, chronic facial pain, tissue and organ regeneration, vaccines to manage infectious diseases, an array of congenital and acquired craniofacial malformations, cancers, diabetes, and other diseases and disorders. Formal and informal collaborations are formed between nations, states, cities, universities, schools, departments, small groups, and individual scientists and clinicians.

Advocacy

Advocacy—speaking or writing on behalf of a cause—has become profoundly important for the support of higher education (public and private), science, and a large number of diseases and disorders. Advocacy can result in the identification of a new field of inquiry, an increased interest in an “orphan” disease or disorder, increased funding for a specific disease or disorder, and beyond. When considering dental schools (faculty, students, residents, staff, alumni, patients, and friends), advocacy is developed through the realization and unification of diverse self-enlightened interests. Often, crisis is a catalyst for advocacy: the threat (real or perceived) of extinction. Often also, a critical component of leadership in the oral health professions is the skill set to mobilize diverse groups around an advocacy issue.24,25

Exemplary Individuals

From 1936 to the present, the individuals mentioned here have been exemplars for the impact of scientific discovery and innovations upon dental education.

Herbert Cooper, an orthodontist working in Lancaster, Pennsylvania, created the first craniofacial team in 1939. Cooper realized that a team of experts, focusing on the developmental needs of a child and related family, was the urgently needed approach for the diagnosis and treatment of congenital craniofacial anomalies. Such craniofacial teams are now distributed around the nation and have stimulated a team approach in cardiology, oncology, and orthopedics.

From the 1930s to the 1960s, Trendley Dean, the first dentist appointed to the U.S. Public Health Service (USPHS) and the NIH, along with his colleague Francis Arnold, pioneered the epidemiology of fluorosis, the chemistry of fluoride, and the significant benefit of preventive interventions using fluoridated drinking water to reduce tooth decay in children. Both men worked as scientists within the USPHS. Dean became the first director of the NIDR in 1948, and Arnold became the second director in 1956.

Norman Simmons, a dentist who graduated from Harvard before pursuing a postdoctoral fellowship with Rosalind Franklin in England in the early 1950s, isolated and purified the DNA extracted from adenovirus particles that led to the first x-ray crystallography images that suggested a double helix and base pairing between adenine and thymine and between guanine and cytosine. Simmons went on to a distinguished career in the biological effects of radiation during his career at the University of California, Los Angeles (UCLA).

Robert Ledley, a dentist who graduated from New York University (NYU) in 1948, worked initially at the Bureau of Standards in Washington, DC, and went on to discover 3-D computer-assisted tomography (PET and CAT scans) and algorithms for nucleic acid/amino acid integration and user-friendly searches of databases.

Raphael Bowen, a dentist who graduated from the University of Southern California (USC), was keenly interested in the chemistry of adhesion and went on to discover dental sealants and composite resins while working at the ADA George Paffenbarger Research Institute in Gaithersburg, Maryland, in the 1960s through the 1990s.

Karl Piez, George Martin, Vince Hascall, Hynda Kleinman, Paul Bornstein, and John Termine worked together, often as a team, within the Intramural Scientific Program of the NIDR from the 1960s through the 1990s. They discovered the biochemical constituents of the extracellular matrices (collagens, proteoglycans, glycosaminoglycans, fibronectins, laminins, amelogenins) of many biological tissues including skin, cartilage, bones, and teeth.

Steve Mergenhagen at NIDR, Sig Socransky at The Forsyth Institute in Boston, and Bill Costerton in Montana each led large NIDR-supported teams of scientists with a shared interest in infectious bacterial pathogens. They discovered oral bacteria that could be cultured or not cultured. Their studies included the pathogenesis and mechanisms of many oral infectious microbial diseases and related host immunity. Costerton was also responsible for an intellectual synthesis that described his term “biofilms” as the 3-D habitat or tissue-like structure that contains an elaborate ecosystem of many oral pathogens.
Robert Genco, Roy Page, and Russell Ross, as well as Harald Löe, Robert Fitzgerald, Paul Keyes, and Pers Branemark, contributed to understanding the pathogenesis of chronic destructive periodontal diseases and disorders, other chronic connective tissue disorders, and advances in therapeutics for gingivitis and periodontal diseases and innovations such as guided tissue regeneration and dental implants.

Edward Driscoll and Ron Dubner, both dentists working in the NIDR Intramural Scientific Research Program, were responsible for defining and advancing the science and management of acute and chronic facial and oral pain. Dubner, in particular, was the primary architect for a superb transprofessional and interdisciplinary approach to pain and pain management. He created one of the first research teams that spanned from the molecular to patient care in an expansive approach to the study of chronic facial pain and beyond.

Sam Pruzansky (Illinois), John Converse (NYU), Peter Randall (Philadelphia), Paul Tessier (Paris), and Sy Kreshover (as third director of NIDR) as well as Harold Slavkin (USC and sixth director of NIDR) were critically important for the creation and growth of the field of craniofacial biology, with emphasis upon interdisciplinary, transprofessional approaches to patient care. During Slavkin’s tenure at the NIH, the NIDR name was changed to the National Institute for Dental and Craniofacial Research (NIDCR) to reflect the depth and breadth of its scientific portfolio and mission.

Lois Cohen (NIH) and Sam Dworkin (University of Washington) are exemplars of the impact of the social and behavioral sciences upon domestic as well as global oral health agendas. Their pioneering work informs dental education, clinical practice, regional and community health programs, and prevention programs designed to improve oral health in the United States and around the world.

Robert Gorland, Michael Cohen Jr., Mal Snead, Jim Simmer, and Tom Hart all trained in dentistry before graduate training, and Mary MacDougall and Mary Marazita both earned a Ph.D. in the biological sciences. Collectively, these people serve as exemplars for the introduction of molecular biology and genetics into dental education and studies that define the role of genetics as a basis for dental diseases and disorders.

Steve Offenbach (North Carolina) and Marjorie Jeffcoat (Philadelphia), both dentists with specialty training in periodontics, along with Jim Beck (North Carolina), pioneered the oral-systemic connection starting in the mid-1990s, considering an association with cardiovascular diseases and low-birthweight, premature infants. Their pioneering work enabled a number of clinical trials designed to test the hypothesis that oral microbial infections contribute to several chronic diseases and disorders.

Silvio Gutkind, working within the Intramural Scientific Program of the NIDR and NIDCR, pioneered the use of genomics to identify and characterize candidate gene mutations associated with oral and pharyngeal cancers. His studies, as well as those of hundreds of others, inform the multiple genes environment basis for the diagnosis of oral, nasal, and pharyngeal cancers. These studies further provide the foundation for future targeted therapeutics to be developed for the prevention and/or treatment of head and neck cancers.

Irwin Mandel, Larry Tabak, David Wong, Dan Malamud, Paul Denny, and Mahvash Navazesh each contributed to advancing innovations using saliva as an informative body fluid, informative for diagnostics, assessment of the progression of disease, and the effectiveness from the progression of therapy.

Prospectus for the Future: Challenges and Opportunities

In the mid-1930s, the world’s population was less than 2 billion. Today, it is more than 6 billion. Presently, the United States is the third largest nation in the world with more than 300 million people. The twenty-first century began in the United States with the horror of 9/11 and the aftermath of two wars, a decline in K-12 public education, sharp divisions on ideas and ideals among the citizenry, and national unemployment of 9 percent in light of a horrific recession that reduced accumulated wealth by as much as 30 percent for many millions of people. Independent of these forces, our nation’s population continues to grow by more than 1 million per year.

These major issues have profound influences on public as well as private university-level education including dental education. Federal and state budgets are woefully inadequate to meet educational needs for the twenty-first century, while physical infrastructure and renewal of faculty resources require significant investments to compete within the current international environment. The present cost of dental education as well as the rate of tuition expense increase
is simply not sustainable. Innovation is desperately required to improve dental education, the quality of comprehensive oral health care, and access to quality care for all Americans.

At the same time, discoveries from the physical, chemical, biological, and behavioral sciences have been and continue to be truly extraordinary. Soon after the discovery of the structure and suggested functions of DNA, Sir Francis Crick proposed “that we are now entering the biological revolution.” Indeed, oral health professionals (teachers, scientists, clinicians) are living and functioning within the nexus of three dominant fields of inquiry: a digital revolution, a biological revolution, and a nanotechnology revolution. Science is the fuel of technology and the foundation for health professions education. In dental education, as in all other health professions, science and scientific activity inform basic understanding of development, structure, and function and serve as the platform for diagnosis, treatment planning, treatments and therapeutics, and predictable outcomes for diseases and disorders.8–10,26–28 In acknowledgment of the illustrious past seventy-five years that we are celebrating, I raise a glass of wine and assert, “The best is yet to come.”

REFERENCES