EDITORIAL

The future of oral health professions: Molecular dentistry (An essay)

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The human characteristics of curiosity and wonder and ingenuity are as old as mankind. For tens of thousands of years people around the world have been harnessing their curiosity into inquiry and the process of scientific methodology. The international fruits of these endeavors have resulted in agriculture, transportation, global networks of communications, energy resources, housing, environmental considerations, enhanced computational powers, entertainment, and biomedical research that has improved the quality of life as well as the human lifespan during the 20th century in many nations around the world.

Science is the fuel of the engine of technology! Science is the fuel of progress in the clinical fields of dentistry, medicine, pharmacy and nursing! Oral health practice has now entered the era of "evidence-based dentistry," characterized by an increasing societal belief in many nations around the world that clinical practice should be based on scientific information rather than intuition or personal opinion. Scientific inquiry coupled with advances in technology has made enormous progress in the last 100 years -- air conditioning, personal hygiene, education, antibiotics, water purification as well as fluoridation. These and complementary advances have changed the average human lifespan from 45 years in 1900 to 80 years by 2000 throughout the industrial nations of the world. Science has made a profound difference in the quality of life for billions of people. These benefits coupled to scientific advances are especially evident in modern dentistry and medicine.

Molecular dentistry, the human genome project, transcriptomes and proteomes have recently opened vast opportunities for translation of basic science discoveries to oral health care at the chairside and bedside through the intermediary process of clinical research. Although the importance of curiosity and innovations through research have been known and appreciated for thousands of years, education and training of the oral health professional community about the process of discovery, from basic discovery through clinical applications influencing and improving standards of oral health care, has not received sufficient emphasis until recently.

What are some of the highlights? At the end of the 17th century, Antonj van Leeuwenhoek invented the light microscope and he provided excellent descriptions of microbes in dental plaque growing on the surfaces of his teeth. Thereafter, the "cell theory" led to histology and pathology and a variety of microscopes designed to visualize the elements of life even better - - - scanning and electron microscopy, atomic force microscopy, and confocal microscopy. Through these incredible "ways of seeing and knowing," more than 500 species of bacteria have been identified within the biofilms located upon tooth and oral mucosal surfaces. We now appreciate that these oral microorganisms can become virulent and challenge systemic health through low birth weight, prematurity as well as periodontal, pulmonary and cardiovascular diseases.

In the 19th century, Gregor Mendel advanced his principles of genetics. In the 20th century international teams of scientists and clinicians defined modern human genetics and their efforts led to the completion of the international Human Genome Project by April 2003; all of the human genes were identified and mapped to their respective locations of chromosomes as well as to mitochondria. A new era of gene-based diagnostics and therapeutics began. Thousands of human genetic diseases can now be identified. Tens of thousands of new therapeutics have and are being developed to provide clinical efficacy, specificity and minimal toxicity in oral health care.

Pharmacogenomics and pharmacogenetics provide new insights into how human genetic variations influence individual drug absorption and utilization during therapy - - - viral, bacterial and yeast oral and systemic infection therapy; the management of oral lesions (e.g. herpes, squamous cell carcinoma); the management of bone resorption (e.g. periodontal diseases, osteoporosis, osteopetrosis, osteoarthritis);

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the management of chronic oral and facial pain (e.g. trigeminal neuralgia); the management of autoimmune disorders (e.g. Sjogren's syndrome with xerostomia); and the management of temporomandibular joint diseases and disorders.

Biomimetics ("to mimic biology") describes the new scientific opportunities based upon the recently discovered rules of biology. Today, international teams of scientists and clinicians have the ability and capacity to design and fabricate tissues and organs. Using genetics and stem cell biology methods, biomimetic cartilage, bone, muscle and nerve tissues have been "engineered" and applied to clinical problems. Imagine, this new biomimetic strategy applied through molecular dentistry to improve soft and hard tissue engineering and towards tooth and salivary gland organ regeneration.

Another remarkable advance has been made in "how we clinically visualize diseases and disorders." From Roentgen's discovery of x-radiation and the derivative dental x-rays we now "see" using ultrasound imagining, digital radiography, computer-assisted tomography, and many innovations in magnetic resonance imaging (MRI) with biomarker reporter molecules. Recently, a new quantitative laser fluorescence technology has been successfully applied to the visualization of early dental caries in human teeth, heralding yet another opportunity to enhance sensitivity while reducing or elimination of radiation dosage to patients. In tandem, a new three-dimensional imaging technology enables 360 degrees of "slices" or craniofacial-oral-dental images to be acquired within 74 seconds using computer-assisted technology and a radiation dosage less than routine x-ray bitewing radiographs.

Oral fluids have become "informative fluids" that can be used for diagnostics, the management of drug therapy, and a number of forensic applications. The science and technology of miniaturization (nanotechnology) now enables a full clinical laboratory to be compressed upon a miniature chip and this "lab-on-a-chip" technology is being applied to rapid and sensitive analyses using saliva as a diagnostic fluid.

These and hundreds of other "highlights" reflect a "tipping point" or that time in human history when scientific discoveries are rapidly translated into improved oral health care for people around the world.

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Suggested Readings

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