

# Delving into BioMEMS

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We are very pleased to offer in this issue of *IEEE Pulse* a number of articles focusing on biomedical or biological microelectromechanical systems (BioMEMS) and selected applications related to this exciting field of research. Originally derived from the fields of microelectronics and microsystems, BioMEMS has experienced a tremendous growth over the last decade. It is now poised to have a significant impact on clinical and biomedical applications and can help address some of the most critical health-related challenges in the United States and around the world. In this issue, leading experts in the field come forward to present up-to-date overviews of some of the key application areas, ranging from tissue engineering, global health, clinical diagnostics, drug screening, and drug delivery.

The rising cost of health care is one of the most urgent issues today. The challenges are numerous: the largest ever aging population and a consequent rise in age-related diseases; an urgent need for novel diagnostics in global health-related communicable diseases, as well as non-communicable diseases such as cancer, diabetes, and cardiovascular disease; the enormous costs of drug development and discovery; and a need for personalized and individualized therapeutics and diagnostics. Although these challenges may appear disparate and almost insurmountable, a common thread is that

possible game-changing solutions may be achievable with BioMEMS (alongside nanotechnologies, information technology, and other promising technologies). The articles in this issue, while highlighting some of these impending challenges, also present possible solutions and a way forward for engineers in BioMEMS and related fields to address these critical health challenges.

One of the major areas where microscale applications can make a significant impact is regenerative medicine. Borenstein and Vunjak-Novakovic describe the application of BioMEMS technologies to engineering tissues with controlled microarchitectures in their article. Tissue microvasculature and cell-cell interactions can be controlled by merging microfabrication techniques with advanced biomaterials to generate microfabricated tissue structures with enhanced function or control stem-cell differentiation for generating a renewable source of cells for transplantation. In addition, Seker et al. describe the use of cell-based systems for generating tissues on a chip. In such systems, cells can be integrated within microscale systems such as microfluidic chips. Such cell-containing devices can be used for generating miniaturized systems on which cell behavior can be monitored upon exposure to various chemicals for drug discovery applications.

Another area that can benefit from the use of microfabricated technology is drug delivery. In an upcoming issue of *IEEE Pulse*, Ferrari et al. will describe the use of BioMEMS approaches for drug delivery. Microfabricated technologies can be used to generate microchips that can deliver drugs in a controllable manner. Furthermore, such techniques can be used to generate micro- and nanoparticles with controllable shapes that enable more controlled delivery of drugs to particular tissues in the body for a range of diseases such as cancer.

Microscale technologies can also be used to develop cheap and portable devices for diagnostics. Two articles in this issue outline various uses of microscale technologies for global health and clinical diagnostic applications. In one, Fu et al. describe the use of microfabricated technologies for a range of diagnostic diseases. In the article by Watkins et al.,

the authors discuss the potential of microfluidic systems for a range of clinical and diagnostic applications including blood cell counting, detection of CD4<sup>+</sup> cells for diagnosing the progression of HIV/AIDS in patients in resource-limited settings, and bacterial detection.

Additionally, these technologies need to be translated to the market place so as to provide solutions for the betterment of the public. We also present a short discussion with two leading scientists (Stephen Quake and Shu Takayama) who have translated biomedical microtechnologies into a commercial arena.

We hope that you enjoy reading these articles. Please feel free to provide any feedback.

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