A Special Issue Devoted to the 7th World Congress of Biomechanics

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The 7th World Congress of Biomechanics (WCB) was held in Boston, Massachusetts, July 6-11, 2014. This is a meeting held once every four years, rotating among Asia, Europe, and North America, with the last meeting in 2010 having been held in Singapore. These meetings are organized by the World Council of Biomechanics, an international organization, and represent the entire spectrum of topics from molecules to whole body kinematics, from basic to applied. The objective of the Council is to provide permanence and stability for the WCB, and to communicate information about the Congress and any associated satellite meetings, as well as to promote the scientific priorities in Biomechanics to the broader community. The first WCB was held in San Diego in 1990, organized by Prof. Y.C. Fung, and this year's meeting upheld the fine tradition established over the years.

Organized in conjunction with nine other biomechanics organizations, the 7th WCB attracted more than 4000 attendees, with 20 parallel sessions and 16 plenary lectures, making it the largest ever gathering of the biomechanics community. Along with traditional tracks in cardiovascular biomechanics, musculoskeletal biomechanics, whole body motion, etc., a substantial expansion in the field of cell mechanics and mechanobiology was noted at the 2014 meeting. In order to highlight the growth and rapid discoveries in this exciting area, we have put together this special issue based on original research and reviews of hot topics from the WCB with a focus on molecular and cellular scales.

In keeping with the spirit of the WCB we invited original articles and reviews from laboratories from around the world with representation from Singapore, Japan, France, Germany, the United Kingdom, and the United States. In order to make the task of combing through over 5,000 abstracts manageable we enlisted help from the WCB track chairs to help us identify notable abstracts that highlight exciting and innovative research in all areas of cellular and molecular biomechanics. We also selected from the top reviewed abstracts to provide our readers with papers that we feel are representative of the uniformly outstanding work presented at the congress.

Lim and colleagues begin this special issue with a review on the mechanics of collective cell migration (CCM) for adherent epithelial cells. Expanding upon what is known about single cell migration, this review provides an overview of CCM and describes recent discoveries on how cell-cell and cell-matrix interactions combine with other mechanical cues to produce emergent CCM behaviors critical to processes, such as development, wound healing, and metastasis. Such behaviors rely in part on mechano-transductive communication between adjacent cells via intercellular force transmission through adherens junctions (AJ). **Adachi et al.** shed more light on AJ by describing molecular level mechanical tests on β–catenin, an intracellular component of AJ, using atomic force microscopy (AFM). They show that this protein, which is believed to function as a tension transmitter, demonstrates nonlinear elastic behavior under tension, which could enable adjacent cells to

remain attached at low force and maintain mechanically stable connections while transmitting high forces. In another application of AFM related to AJ, **Liu et al.** use a technique termed single cell force spectroscopy (SCFS) to measure changes in the adhesive and mechanical properties of β cells treated with anti-E-cadherin. These results shed new light on dynamic mechanical interactions between cell adhesion proteins and the cytoskeleton.

Sander and colleagues describe differences in keratinocytes colony formation on soft and stiff polyacrylamide substrates. Time-lapse images show enhanced cooperativity and faster colony formation amongst keratinocytes on soft substrates that appears correlated with cell-cell mechanical signaling generated via local substrate deformations and increased expression of β4 integrin on the colony margins. **Setton et al.** also report on the important roles that cell-cell adhesions and substrate stiffness play in regulating cell behavior, this time with respect to the clustering ability of juvenile nucleus pulposus (NP) cells. They show that N-cadherin and a soft, laminin-rich substrate promote cell clustering, preserve juvenile NP phenotypic markers, and maintain proteoglycan synthesis. These results suggest that alterations in cell-cell adhesions and clustering could underlie the *in situ* changes in NP phenotype and morphology associated with aging and intervertebral disc degeneration. Another area where mechanical environment and aging intersect is with respect to endothelial cell senescence. **Truskey and colleagues** describe experiments on human umbilical chord blood derived endothelial cells (hCB-ECs) with less than 31 (young) or more than 44 (aged) population doublings. Aged hCB-ECs exhibited increased traction forces and changes in actin cytoskeletal organization due to age-associated alterations in the glycocalyx and SIRT1, an enzyme involved in antioxidant activity and energy metabolism.

Cell-substrate, cell-cell and cell-protein interactions might also be involved in other pathophysiological contexts, such as in cancer metastasis. For example, epithelial-stromal mechanical interactions in the tumor microenvironment are important determinants of tumor growth and metastatic potential. **Reinhart-King and colleagues** present more quantitative information on biophysical differences between primary stromal fibroblasts obtained from breast tumor tissue and healthy contralateral breast tissue following double mastectomy. Fibroblasts from tumors exerted significantly larger tractions forces and exhibited increased migratory potential and ECM remodeling compared to fibroblasts from healthy breast tissue. Cell mechanics also plays an important role in cancer metastasis and invasion. **Dong and coworkers** review the current understanding in the field of how fibrin and cell adhesion receptors facilitate metastatic cancer cell adhesion in the circulatory system. They furthermore highlight evidence for an association for thrombotic events and elevated coagulation pathways associated with metastasis. This perspective report summarizes over a decade of work primarily conducted within the bioengineering community specific to the field of cancer cell adhesion in the vasculature. These results have shed light on the significant interplay between cancer cells, immune cells, and the endothelium under shear conditions, which is key in the struggle to better diagnose and treat cancer metastases.

Finishing off this special issue are two review articles. First, **Grashoff and coworkers** provide a much-needed refresher and guide for selecting amongst the many options in FRET based tension sensors, particularly with regards to measuring molecular level forces as low as 2 pN in magnitude. Finally, **Butler and collaborators** describe potential roles for impulsive enzymes. These are enzymes that, in addition to their primary function as catalysts for various reactions, secondarily generate forces from the conversion of chemical energy to kinetic energy. Such forces allow these enzymes to move directly up the substrate concentration gradient, or if the enzymes remain stationary, pump fluid in a directed manner. These forces could potentially play an important role in many mechanobiological processes. We hope that you will enjoy the articles in this special issue, which we feel represent exciting and emerging areas in biomechanics. Be sure to follow the latest developments in Cellular and Molecular Bioengineering on Facebook (www.facebook.com/CMBEjournal) and Twitter (www.twitter.com/CMBEjournal)!