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Editorial

Recent developments in biophysics & molecular biology of heart rhythm

Our understanding of normal heart rhythm and its dysregulation in disease is continuously evolving, driven by experimental and theoretical investigations across the spatial and temporal scales of cardiac structural and functional integration (Quinn and Kohl, 2013). The purpose of this special issue of *Progress in Biophysics and Molecular Biology* is to present recent advances in heart rhythm research, from the sub-cellular and tissue levels, to the whole heart, and in human – using both experimental and computational approaches. We are thankful to *PBMB* for the opportunity to bring together the work of various leading investigators in this highly interdisciplinary field.

The special issue contains a selection of original research articles and reviews. The first series of papers are primarily concerned with aspects of ion channel function in the heart, beginning with four papers providing molecular-level insight, followed by six papers focussed on functional consequences of (patho-)physiological channel dynamics. This includes a wide array of both experimental and computational methodologies, commencing with a description of voltage-clamp fluorometry for simultaneous observation of ion current kinetics and channel conformational changes (Zhu et al., 2016) and a theoretical investigation linking conformational changes in Kv7.1 to its electrophysiological function (Nekouzadeh and Rudy, 2016). This is followed by overviews of the influence of the Popeye domain-containing protein family (Schindler and Brand, 2016) and natriuretic peptides (Moghtadaei et al., 2016) on cardiac electrophysiology. Next we learn about cell-specific dynamic clamp analysis of the hyperpolarisation-activated 'funny' current (Ravagli et al., 2016), cellular consequences of *human ether-a-go-go related gene* 1b-specific mutation (Jones et al., 2016), the potential role of mutant sodium channels and environmental triggers in Brugada and Long QT 3 syndromes (Peter et al., 2016), the importance of drug binding kinetics and state-dependent affinity for acquired LQT syndrome (Lee et al., 2016), and new methodologies for simulation of cardiac cellular electrophysiology (Clerx et al., 2016) and its variability (Muszkiewicz et al., 2016).

The second collection of thirteen papers is centred on integrative cardiac electrophysiology, including the role of fibroblasts, determinants of electrical conduction, causes of electrical instability, and aspects of mechano-electric function. This begins with discussions of the evidence for electrical coupling of fibroblasts to myocytes (Mahoney et al., 2016) and thoughts on how we might engineer better scars after myocardial infarction and ablation (Holmes et al., 2016), followed by an investigation of the contribution of fibroblasts to the protective effects of ursodeoxycholic acid in the human fetal heart (Schultz et al., 2016). We then move on to reports of the microanatomy of sinoatrial conduction pathways in the human sinoatrial node (Csepe et al., 2016), the state-of-the-art in interspecies mathematical modelling of the His-Purkinje system (Vigmund and Stuyvers, 2016), and the effects of perfusate composition on myocardial conduction in isolated hearts (George and Poelzing, 2016). At this point we shift gears and hear about the roles of the cardiac nervous system (Ripplinger et al., 2016), abnormal calcium handling (Nemec et al., 2016), and dispersion of ventricular repolarization (Opthof et al., 2016) in contributing to arrhythmogenesis, as well as a computational investigation of the modulation of arrhythmia risk by potassium current block in ischemic human ventricles (Dutta et al., 2016). The final group of papers emphasises the importance of mechano-electric considerations for regulation of cardiac function (Quinn, 2015, 2014; Quinn et al., 2014), first through a review of the seminal work of Prof Vladimir Markahasin regarding the relevance of myocardial mechano-electric heterogeneity (Solovyova et al., 2016), followed by investigations of the effects of sex on regional electro-mechanical dysfunction in long QT syndrome (Lang et al., 2016) and of sarcomere length and thin filament remodelling in human heart failure (Zile and Trayanova, 2016).

While only a snapshot of some of the most *Recent Developments in Biophysics & Molecular Biology of Heart Rhythm*, the guest editors hope that the special issue serves to spotlight new and exciting areas of research, ultimately stimulating innovative pathways for future work.

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