Award Details

Nonlinear dynamics of coupled oscillator networks underlying control of gut motility

Research Details

Competition Year:	2017	**Fiscal Year:**	2017-2018
Project Lead Name:	Huizinga, Jan	**Institution:**	McMaster University
Department:	Medicine - Medicine	**Province:**	Ontario
Award Amount:	40,000	**Installment:**	1 - 5
Program:	Discovery Grants Program - Individual	**Selection Committee:**	Genes, Cells and Molecules
Research Subject:	Linear and non-linear systems	**Area of Application:**	Modelling and mathematical simulation of natural processes
Co-Researchers:	No Co-Researcher	**Partners:**	No Partners

Award Summary

Motility of the gut to facilitate absorption of nutrients and transport along the alimentary canal is essential for life. Yet we still know little about control mechanisms of motility, in particular in the intestine and colon. My laboratory has unique expertise in pacemaker cells of the gut, the interstitial cells of Cajal (ICC), and it is these cells that dominate control over pattern generation of motility.
In the 1990s my laboratory discovered that ICC have electrical oscillations that initiate contraction of gut muscle cells, resulting in publications in high impact scientific journals (Nature and Nature Medicine). This explained why contraction patterns are usually rhythmic (the ICC oscillate), but little else. To explain the patterns themselves we need to understand how ICC interact with each other in space and time, and this is the subject of our research proposal. ICC line the whole length of the gut and form a number of separate, net-like layers of cells (networks) at different depths through the gut wall. **Our idea is that an oscillating ICC can sense both the oscillations of its neighbours in the same network and the oscillations of other ICC networks. We published some groundwork for this proposal in Nature Communication in 2014**. It is these intra- and inter- network interactions that we believe allow complex contractile patterns to be generated. The complex reality of these interactions can only be understood comprehensively with the help of mathematical models and theories. We believe that the best of these theories is **nonlinear dynamics.** The theory is well established, is at the right level of description and in our hands has already shown promise in explaining patterns. **We will discover how ICC behave as networks to orchestrate the complex patterns of gut contraction** that are so vital to life. Canada has the highest rates of inflammatory and functional gastrointestinal disorders in the world, with motility dysfunction as a major or the overriding problem. The strength of our proposal lies in our overall expertise in modeling, physiology, and clinical studies, whereby this proposal focuses only on the mathematical modeling and directly relevant physiological experiments to obtain the model parameters.
Our proposed research will be done through **a training plan that involves close collaboration between trainees in mathematical modeling, physiology and clinical studies**, all within the Farncombe Family Digestive Health Research Institute, where students find a thriving research-training environment. This is supplemented with collaborations with the Departments of Engineering at McMaster and the University of Toronto. The training plan is also facilitated by my directorship of the Honours Biology Pharmacology Coop Program and my associate membership of Biomedical Engineering. We will train students, postdocs and research staff in interdisciplinary translational research.