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MODELLING AND SIMULATION OF THE LYMPHATIC SYSTEM

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MINI-SYMPOSIUM PROPOSAL

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1 ABSTRACT

The lymphatic system consists of a complex network of compliant conduits comprising blind-ended initial lymphatics, pre-collectors, collectors, trunks, ducts and lymph nodes, as well as multiple junctions and valves. The lymphatic system functions in conjunction with other body fluid systems and the immune system and carries excess interstitial fluid (ISF), excess proteins, metabolic waste and immune cells, facilitating immune responses. The lymphatic system drains, asymmetrically, into two sites; the right lymphatic duct and the thoracic duct: the former empties into the venous system at the junction of the right internal jugular vein and the right subclavian vein while the latter empties into the venous system at the junction of the left internal jugular vein and the left subclavian vein.

A number of pathologies are known to be associated with malfunction of the lymphatic system. One example is lymphedema, a disease in which tissues accumulate interstitial fluid, and affects more than 130 million people worldwide. It causes fibrosis of tissues and weakens the immune system. An example of lymphedema is the secondary lymphedema filariasis, a tropical disease which affects mostly Africa, India and south-east Asia and is caused by worms that penetrate the lymphatic system. Another manifestation of lymphedema is the secondary lymphedema after cancer surgery, which is due to the dissection of lymph nodes and causes a blockage in the lymphatic system. Other examples of hereditary lymphedema are the Milroy disease and the lymphedema distichiasis. The lymphatic system is also known to be implicated in the dissemination of cancer, in transplantation and lymphedema associated with breast cancer surgery.

In recent years, the interest in the drainage of the central nervous system (CNS) fluids into the lymphatic system has grown significantly. In addition to the well-established draining routes, it has recently been demonstrated that interstitial fluid from the brain parenchyma is also drained into deep cervical lymph nodes through intramural perivascular spaces around arterial and capillary vessels and through the newly discovered meningeal lymphatic system. Though a precise description of the complex anatomical connections between the various CNS fluid compartments remains elusive, it is expected that anomalies in any of these pathways will have significant effects on the clearance of CNS waste products. CNS fluid compartments are interconnected, and thus a dysfunctional fluid pathway may interfere with the remaining compartments, possibly contributing to the accumulation of neurotoxic metabolic products in the CNS tissue and thus potentially explaining some of the mechanisms at the root of some neurological diseases, for example.

In spite of the importance of the lymphatic system, there is a significant disparity regarding mathematical modelling, as compared to the cardiovascular system, the arterial system in particular. This mini-symposium aims at gathering experts in the lymphatic system and will focus primarily on its

biophysical aspects, the construction of mathematical models and the design of suitable numerical methods for simulations. Strong emphasis on the interconnectivity of this system to other body fluid compartments will be encouraged to gain a holistic, systemic understanding of the basic mechanisms at work. Specific themes to be considered include mathematical models for initial lymphatics, collecting lymphatics, lymphatic valves and lymph nodes. Other aspects are also encouraged, such as targeted experiments to aid mathematical modelling, magnetic resonance imaging to provide measurements and reliable anatomical data for mathematical models, as well as clinical of pathologies associated with the lymphatic system.