Michael Watson
Heriot-Watt University, Edinburgh
e-mail: michael.watson@pet.hw.ac.uk
Dr Steven McDougall
Heriot-Watt University, Edinburgh

Development of the Murine Retinal Vasculature: Mathematical Modelling and Numerical Simulation

Tumour-induced angiogenesis has been extensively explored by the mathematical community. However, despite the availability of animal models with experimentally accesible and highly ordered vascular topologies, there have been few attempts to model angiogenesis during normal development. In this talk we present a mathematical model of the developing retinal vasculature, based on a coupled experimental program of investigation in neonatal mice. Formation of the superficial retinal vascular plexus (RVP) occurs in a spatio-temporally defined pattern. Prior to birth, astrocytes migrate away from the optic nerve over the surface of the inner retina in response to a chemotactic gradient. Astrocytes express further chemotactic, and haptotactic, signals which induce endothelial cell sprouting and growth of the RVP. Adopting a hybrid PDE-discrete approach, the model allows tracking of individual astrocytes and endothelial cells in response to these migratory cues. The simulations provide an excellent correlation with the extent and pattern of astrocyte migration and vascular network formation observed in vivo. The model is extended to include simulation of blood flow through the nascent vessel networks, and oxygen delivery to the surrounding tissues. Dynamic remodelling of the vasculature is then performed, again producing excellent agreement with experimental observations.