# Statistical physics of cell orientations in artificial tissues

**Supervision team:** Dr Jim Hague and Dr Andrew James

**Lead contact**: Jim Hague

**Description**:

The purpose of this soft condensed matter physics / biophysics PhD project is to study the properties of cells in artificial tissues, using statistical physics techniques, building on our experience in this area [1]. Cells in artificial tissues are important physically because of the range of complex behaviours and forces on multiple length scales, and biologically because of their promise for regenerative medicine and their potential for reducing and replacing the need for animal testing during medicine development. We need large-scale simulations of the structures that are formed by cells in tissues, in order to obtain insight into complex behaviours of tissues critical to life on a macroscopic scale. We need to increase the range of tissue systems that can be described using microscopic models, as a step towards general and widely applicable models of cell behaviour. We need to improve understanding of cellular interactions on microscopic scales, in order to increase control of artificial tissues on a cellular scale.

In this project, numerical methods will be developed, the methods will be applied to the modelling of cell structures and other ordering in artificial tissues and finally validated against a wide range of different tissue types. You will develop numerical methods based on computational intelligence and the tools of statistical physics, in order to make large-scale simulations of the structures that are formed by cells in tissues. You will enhance our existing model with new physics, in order to increase the range of tissue systems that can be described using microscopic models. You will use mathematical methods to gain insight into the key behaviour of these enhanced models, in order to improve understanding of cellular interactions on microscopic scales. During this PhD, you will develop skills in simulation techniques, computer programming and mathematical techniques, key to the theory of statistical physics, and also highly transferrable to a variety of different academic disciplines and other career areas.

**References:**

1. Microscopic biophysical model of self-organization in tissue due to feedback between cell- and macroscopic-scale forces. J. P. Hague, P. W. Mieczkowski, C. O'Rourke, A. J. Loughlin, and J. B. Phillips. Phys. Rev. Research 2, 043217 (2020).

**Qualifications required**:

Good first degree in physics or possibly related subject (e.g. applied mathematics, computing), preferably at master's level.