Professor Mark A.J. Chaplain F.R.S.E
President of the Edinbugh Mathematical Society University of Dundee

Multiscale mathematical modelling of cancer growth

Cancer growth is a complicated phenomenon involving many inter-related processes across a wide range of spatial and temporal scales, and as such presents the mathematical modeller with a correspondingly complex set of problems to solve. In this talk we will present multiscale mathematical models for the growth and spread of cancer and will focus on three main scales of interest: the sub-cellular, cellular and macroscopic. The sub-cellular scale refers to activities that take place within the cell or at the cell membrane, e.g. DNA synthesis, gene expression, cell cycle mechanisms, absorption of vital nutrients, activation or inactivation of receptors, transduction of chemical signals.

The cellular scale refers to the main activities of the cells, e.g.
statistical description of the progression and activation state of the cells, interactions among tumour cells and the other types of cells present in the body (such as endothelial cells, macrophages, lymphocytes), proliferative and destructive interactions, aggregation and disaggregation properties. The macroscopic scale refers to those phenomena which are typical of continuum systems, e.g. cell migration, diffusion and transport of nutrients and chemical factors, mechanical responses, interactions between different tissues, tissue remodelling.

The models presented will be either systems of nonlinear partial differential equations or individual-forced based models and, in addition to presenting our computational simulation results, we will discuss some analytical and numerical results and issues. Finally, we will present an overview of recent analytical results in the area concerning a new notion of multiscale convergence, called "three-scale convergence".