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MICRO, MESO AND MACRO: MATHEMATICAL MODELLING OF CANCER AT MULTIPLE SCALES OR MULTISCALE CANCER MODELLING?

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ABSTRACT

The past few decades have witnessed enormous advances in our understanding of the molecular basis of cell structure and function. Life scientists and clinicians are now recognising the need to integrate data across a range of spatial and temporal scales (from genes to tissues) in order to fully understand the systems they are studying. One specific example of such a biomedical system, is cancer growth – a complicated disease involving many inter-related cellular processes across a number of scales.

However, when considering tissue level phenomena, there are three natural, key scales linked to each other which, when considered together, go to make up understanding the process as a whole: the sub-cellular scale, the cellular scale and the tissue scale itself. 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 individual cells, e.g. statistical description of the progression and activation state of the cells, interactions among different types of cells present in the body (e.g. epithelial cells, endothelial cells, macrophages, lymphocytes, neurons), proliferative and destructive interactions, aggregation and disaggregation properties. The tissue 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.

I will present some recent mathematical models of cancer growth and development which focus on different scales – intra-cellular, inter-cellular and tissue, or micro-, meso-, and macro-scales respectively. The results of the models will be compared with experimental data and some indications of how to develop a unified multiscale mathematical model will be discussed.

REFERENCES

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