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MATHEMATICAL MODELLING TO GUIDE CANCER RESEARCH AND ENHANCE CLINICAL ONCOLOGY

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ABSTRACT

Cancer is one of the leading causes of mortality worldwide. Tumours evolve, adapt, and exploit their environment in ways that experiments alone cannot easily capture. Tumour complexity spans molecular heterogeneity, dynamic tumour–host interactions, treatment resistance, and patient-to-patient variability. Mathematical modelling and computational approaches offer a way to translate multi-scale biological data into predictive frameworks and reveal mechanisms that experiments alone often cannot isolate. Nowadays, models help us understand how tumours grow and invade surrounding tissue, predict how patients will respond to therapy, and design smarter treatment protocols that avoid resistance.

This minisymposium brings together researchers at the intersection of mathematical modelling, computational biology, and clinical oncology to present how rigorous modelling is shaping the next generation of cancer research and patient care. Contributions are invited from all areas where researchers working on mathematical and computational tools are advancing our understanding of approaches to tumour biology, treatment response, and improving clinical decision-making, including but not limited to:

- Multi-scale models of tumour growth, invasion, and metastasis
- Mechanistic and data-driven modelling of treatment response, including chemotherapy, radiotherapy, targeted agents, and immunotherapy
- Optimisation and control of treatment schedules, including adaptive therapy and strategies to manage resistance
- Patient-specific modelling and digital twins, calibrated from clinical imaging and clinical data
- Modelling the tumour microenvironment, including angiogenesis and immune interactions
- Pharmacokinetic and pharmacodynamic modelling for drug development, delivery, efficacy, and toxicity
- Machine learning and hybrid physics-informed approaches in oncology

- Evolutionary and game-theoretic frameworks for tumour heterogeneity
- Mathematical frameworks to support clinical trial design and in silico experimentation

This session will provide a forum for exchanging ideas across disciplinary boundaries, from applied mathematicians and biomedical engineers to computational scientists. We welcome contributions that bridge rigorous mathematics with clinical relevance and demonstrate translational potential. The event aims to advance the vision of precision oncology, in which mathematical models can support clinicians in providing tailored and effective patient care.