

Artificial Life in the Fight Against Cancer

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Blood vessel growth is a fascinating example of an adaptive, morphologically plastic network formation process driven by complex interactions between individual cells in the vessel and between the cells and their dynamic extracellular environment. Under normal conditions this can generate a well-adapted hierarchical branching structure. However in tumours, blood vessels become maladapted, leaky and bulbous, resulting in increased hypoxia and tumour cell metastasis. A method to switch tumour blood vessels back to a normal network could reduce metastasis and thus represents a significant goal in cancer therapy. However, studying human disease and the abnormalities that lead to pathological phenotypes is a monumentally difficult task. Humans don't tend to offer themselves for experimentation and animal disease models can be hard to establish. Probing the inner workings of *in vivo* systems present numerous technical challenges, though boundaries continue to be broken. Further, the *normal* fundamental mechanisms controlling development are of course not fully understood, let alone their perturbation by environmental changes in disease.

Artificial Life (ALife) aims to instantiate and study biological principles of organisation in new media in order to exploit different methods to test the system uniquely available in that medium. Thus ALife can perfectly complement cutting edge *in vivo* research giving vital temporal, spatial and organisational understanding of the process, if we work together with biologists, to build data driven models, and test emergent properties. At Cancer Research UK working closely within the Vascular Biology experimental Lab we have made new advances, through an integrated ALife-experimental approach, in the understanding of blood vessel growth. The emergent properties of the embodied, agent-based model we developed when put into a disease environment, have led to the discovery of a novel switch in cell communication which is changing the way we think about tumour malformations. These emergent behaviours have proved strongly predictive when tested *in vivo* and are continuing to inspire new experimental research and generating a fuller understanding of the underlying organisation required to generate functional, adaptive blood vessel networks.