Emergence of microstructural patterns in skin cancer

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Abstract

Clinical diagnosis of skin cancers is based on several morphological criteria, among which the presence of microstructures (e.g. dots, nests) [1] sparsely distributed within the tumour lesion (see Figure 1). In this study, we demonstrate that these patterns might be originated by a phase separation process using a continuous multiphase model [2].

In absence of cellular proliferation, in fact, a binary mixture model, which is used to represent the mechanical behaviour of skin cancers, contains a cell-cell adhesion that leads to a governing equation which ressembles to a Cahn-Hilliard type equation.

Taking into account a reaction-diffusion coupling between nutrient consumption and cellular proliferation, we show, both with analytical and numerical investigations, that two-phase model may undergo a spinodal decomposition even when considering mass exchanges between the phases.

The cell-nutrient interaction defines a typical diffusive length in the problem, which is found to control the saturation of a growing separated domain, thus stabilizing the microstructural pattern. The distribution and the evolution of such emerging cluster morphologies, as predicted by our model, are successfully compared to the clinical observation of microstructural patterns in tumour lesions.

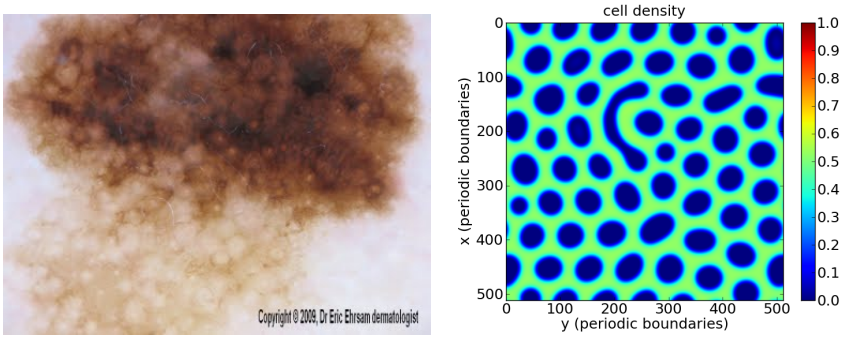

Figure 1: A melanoma presenting an atypical distribution and a cell distribution calculated with our model

[1] G. Argenziano and al., Dermoscopy of pigmented skin lesions: results of a consensus meeting via the internet,*J. Am. Acad. Dermatol.*, **48**, 1211-1212 (2003)

[2]P. Ciarletta, L. Foret, and M. Ben Amar, The radial growth phase of malignant melanoma, *J. Roy. Soc. Interface*, **8**, 345-368 (2011)