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A BASIC MODEL FOR THE DESCRIPTION OF EPIDERMIS STRUCTURE
well-posedness analysis, numerics and simulations

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The epidermis (the outermost part of the skin) is a stratified epithelium formed by multiple layers of cells that undergo a continuous renewal process. In the innermost layer (the basal cells layer) cell proliferation occurs. Progenitor cells produce quiescent differentiated cells (post-mitotic keratinocytes) that detach from the underlying basement membrane and move outward forming the suprabasal layers. Suprabasal cells undergo a progressive maturation, called keratinization and, at the end of this process, cells filled of keratin die, and the dead cells (corneous cells or corneocytes) form the stratum corneum. The inner cells of the stratum corneum adhere each other, but, when the corneocytes are pushed to the surface by newly formed cells, they lose their adhesion and eventually are shed from the surface, through a process named desquamation.

To describe the process outlined above, we propose a model with age and space structure, including different types of cells (proliferating cells, differentiated cells, corneous cells, and apoptotic cells) that move with the same velocity, under the constraint that the local volume fraction occupied by the cells is constant in space and time. The stationary state of the model corresponds to the spatial organization of the normal, homeostatic epidermis, or the state that may be reached after prolonged and time-invariant damaging. This state should also be the limit of the time evolution of the skin after any perturbation. Existence of a solution, both in the stationary and in the dynamic case, requires conditions that can be viewed as parameters restrictions for skin formation. A numerical scheme to compute the solution of the model is proposed and simulations are provided for realistic values of the parameters.

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