RESUMO N° 90

THREE DIMENSIONAL COLONIC CRYPT MODEL

Giuseppe Romanazzi, roman@mat.uc.pt
CMUC, Universidade De Coimbra, Portugal

Isabel Figueiredo, isabelf@mat.uc.pt
CMUC, Universidade De Coimbra, Portugal

Carlos Leal, carlosl@mat.uc.pt
CMUC, Universidade De Coimbra, Portugal

Keywords: Convection-Diffusive Model, Finite Elements, Colorectal Cancer, Colonic Crypts

Colorectal cancer is one of the most frequent type of cancer in the western world [1]. Different scientific communities have studied its morphogenesis from geneticists to computing scientists [2]. The colon is a suitable place for the appearance of cancer because of its continuous self-renewal with a large number of cell divisions per day. The inner part of the colon is lined by millions of small pits, called crypts and it is widely accepted that the cell mutations in the epithelial part of the crypts are responsible for the cancer initiation process [3]. The goal of this work is to model inside a three dimensional crypt structure the density of three cell families: living normal and abnormal cells, and apoptotic cells.

The proposed 3D crypt model is a generalization of the model used in our previous works (see for instance [4,5]) to simulate the Aberrant Crypt Foci dynamics.

This model involves a parabolic reaction diffusion equation, describing the cell density, coupled with an elliptic equation, defining the cell pressure. The numerical discretization of the model is performed by using suitable finite elements.

By considering this real 3D scenario, for a colonic crypt, we analyze and compare in silico the possible different behavior induced in its morphogenesis and cell dynamics, by changing in the model, both the diffusion coefficients and rate of proliferation parameters of the colonic cells.

References

[1] B.P. Stewart, B. Wild. World Cancer Report, 2014.

[2] S.K. Kershaw, et al. Colorectal cancer through simulation and experiment. IET Systems Biology, 7(3):57--73, 2013.

[3] I.M.M. van Leeuwen, et al. Crypt dynamics and colorectal cancer: advances in mathematical modelling. Cell Proliferation, 39:157--181, 2006.

[4] I.N. Figueiredo, et al. A multiscale model for Aberrant Crypt Foci,

Procedia Computer Science, 18, 1026--1035, 2013.

[5] I.N. Figueiredo, et al. An Homogenization Model for Aberrant Crypt Foci, arXiv:1405.1386, 2014.