NUMERICAL IMPLEMENTATION OF REACTION-DIFFUSION-CHEMOTAXIS MODEL OF CANCER INVASION USING NONSTANDARD FINITE DIFFERENCE METHOD

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ABSTRACT

In this paper we present a nonstandard numerical scheme for solving a reaction-diffusion-chemotaxis mathematical model of migration and invasion of cancer cells. The model is approximated by a system of nonlinear algebraic equations, whose solution is non-negative. The role of the production rate of cancer cells on their invasive ability is analyzed by numerical experiments.

REFERENCES

[1] A.R.A. Anderson, M.A.I. Chaplain, E.L. Newman, R.I.C. Steele, and A.M. Thompson: *Mathematical modelling of tumour invasion and metastasis*, J. Theor. Med. **2** (2000), 129–154.

[2] M.A.I. Chaplain and A.R.A. Anderson: *Mathematical modelling of tissue invasion and metastasis. Cancer modelling and simulation*, Chapman & Hall/CRC Math. Biol. Med. Ser., Chapman & Hall/CRC, Boca Raton, FL, 2003, edited by L. Preziosi, 269–297.

[3] M.A.I. Chaplain and G. Lolas: *Mathematical modelling of cancer cell invasion of tissue: dynamic heterogeneity*, Netw. Heterog. Media **1** (2006), 399–439.

[4] M. Chapwanya, J. M.-S. Lubuma, and R.E. Mickens: *Nonstandard finite difference schemes for Michaelis-Menten type reaction-diffusion equations*, Numerical Methods for Partial Differential Equations **29** (2013), 337–360, DOI: 10.1002/num.21733.

[5] B.M. Chen-Charpentier and H.V. Kojouharov: *An unconditionally positivity preserving scheme for advection-diffusion reaction equations*, Mathematical and Computer Modelling, DOI: 10.1016/j.mcm.2011.05.005 (in press).

[6] A. Estreicher, J. Miihlhauser, J.-L. Carpentier, L. Orci, and J.-D. Vassalli: *The receptor for urokinase type plasminogen activator polarizes expression of the protease to the leading edge of migrating monocytes and promotes degradation of enzyme inhibitor complexes*, J. Cell Biol. **111** (1990), 783-792.

[7] F. Fazioli, M. Resnati, N. Sidenius, Y. Higashimoto, E. Apella, and F. Blasi: *A urokinase-sensitive region of the human urokinase receptor is responsible for its chemotactic activity*, The EMBO Journal **16** (1997), 7279-7286.

[8] G. Lolas: *Mathematical Modelling of the Urokinase Plasminogen Activation System and its Role in cancer Invasion of Tissue*, Ph.D. thesis, Dundee, 2003.

[9] R.E. Mickens: *Exact solutions to a finite difference model of a reaction-advection equation: Implications for numerical analysis.*, Numerical Methods for Partial Differential Equations. **5** (1989), 313–325.

[10] ———— : *Nonstandard finite difference models of differential equations*, World Scientific Publishing, Singapore, 1994.

[11] R.E. Mickens (editor): *Advances in the applications of nonstandard finite difference schemes*, World Scientific Publishing, New Jersey, London, 2005.

[12] W.G. Stetler-Stevenson, S. Aznavoorian, and L.A. Liotta: *Tumor cell interactions with the extracellular matrix during invasion and metastasis*, Ann. Rev. Cell Biol. **9** (1993), 541–573.

[13] A. A. Samarskii: *The Theory of Difference Schemes*, Marcel Dekker Inc, 2001.