A mechanical and numerical approach applied to epithelium topology and development
Yoann Chélin, Karim Azzag, Patrick Cañadas, Stephen Baghdiguian, Bernard Maurin

To cite this version:
Yoann Chélin, Karim Azzag, Patrick Cañadas, Stephen Baghdiguian, Bernard Maurin. A mechanical and numerical approach applied to epithelium topology and development. 18th Congress of the European Society of Biomechanics, Jul 2012, Portugal. pp.1. hal-00686850

HAL Id: hal-00686850
https://hal.archives-ouvertes.fr/hal-00686850
Submitted on 11 Apr 2012

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L’archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d’enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.
A MECHANICAL AND NUMERICAL APPROACH APPLIED TO EPITHELIUM TOPOLOGY AND DEVELOPMENT

Yoann Chélin (1,2), Karim Azzag (1,3), Patrick Cañadas (1,2), Stephen Baghdiguian (1,3), Bernard Maurin (1,2)

1. Université Montpellier 2, France; 2. Laboratoire de Mécancique et Génie Civil, CNRS, France; 3. Institut des Sciences de l’Evolution de Montpellier, CNRS, France

Introduction

A key decisive in the understanding of morphogenesis processes concerns the description of the development of regular topology epithelial tissue as usually observed. The cell pattern is characterized by the average number of the cell neighbours (frequency distribution). Nevertheless, the mechanisms of packing geometry formation, such as the follicular tissue surrounding the Ciona Intestinalis egg, are poorly understood. In order to study further this epithelium development, we made a numerical model based on the mechanics of divided media. Here we propose two scenarii: one governed by cell accretion and the other managed by cell division. With the first one, we explore the influence of the growth rate and with the second one the incidence of mitosis.

Methods

Based on the physics of divided media [Voivret, 2009] the model is managed by contact and at-distance interactions for both the cytoplasm and the membrane. For each grain, the equation of dynamics is solved by using a 4th order Runge-Kutta scheme.

The two scenarii begin considering the same state: ten cells are randomly distributed at the surface of a sphere that represents a Ciona egg. Then, in the accretion scenario, the sphere and the cells grow while new small cells arrive. In the division scenario, the cells grow and afterwards divide and/or die. At the end of the simulation, when the surface is totally covered, the number of neighbours of each cell is counted (fig. 1) and their frequency is deduced.

Results

In the accretion simulations, the obtained numbers of neighbours appear close to the experimental results (fig. 2). The simulations 1 and 2 refer to calculations with a respectively low and high rate of growth.

The results issued from the division simulations are also in good agreement with observed distributions [Gibson, 2006].

Discussion

The fact that the experimental data are enclosed between the two simulation results shows the relevance of the numerical model with this set of parameters. We aim now testing those scenarii with different conditions for division, with two kind of cell with various division speeds or with different boundary conditions (e.g. cell culture boxes).

References