力学学报 2005 37 (3): 317-321 ISSN: 0567-7718 CN: 11-2063/O3

基于微丝主动收缩的细胞分裂的力学模型

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收稿日期 修回日期 网络版发布日期 接受日期

摘要 为了解释动物细胞胞质分裂的力学机理，基于大量的细胞卵裂实验数据，在Zinemanas和 Nir的流体动力学模型基础上，对微丝的分布函数改为随同质膜移动，增加了由于生化刺激引起主动微丝的影响系数. 数值计算表明：此模型能较好地预测细胞在胞质分裂过程中，细胞的总体和局部变形，以及卵裂沟处的张力和细胞内压.

关键词 主动微丝,胞质分裂,收缩环,大变形,张力

分类号 Q66，R318.01

Cell cleavage model based on active microfilaments contraction

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Abstract

The current experiments suggest that the asters of the mitotic apparatus determine the position of the contractile ring during cytokinesis. Ultrastructural observation indicates that microfilaments are bound to the cortex with cross bridges. Microfilaments initially randomly orientate and homogeneously distribute on the membrane. At late anaphase, the microfilaments distribution at the equator plane is changed from random and uniform to aligned parallel. In the present study, on the basis of Zinemanas and Nir's hydrodynamics model, a new model was constructed to stimulate the relationship between the active microfilaments redistribution by biochemical stimulus from the MA asters and cytokinesis. The effective coefficient m due to biochemical stimulus was incorporated into the model, and the distribution function c is modified to move with the plasma membrane motion. In the model, it is assumed that the biochemical stimulus from the asters inhibit the formation of active filaments through a very simple kinetic scheme; the reorientation of active microfilaments follows the cytoplasm flow; the motion of active filaments follows the plasma membrane's motion due to passive deformation. The cell-division is driven by the anisotropic tension of surface. The surface tension consists of two parts: one is the contractile force of the active filaments paralleling to their symmetry axis, the other is the passive deformation tension of the membrane by cytoplasm flowing. The numerical results showed that the active filaments by redistribution due to biochemical stimulus and actively contraction may play a crucial role in cell division. Compared with Zinemanas and Nir's model, the results of our model are more correspondent with the Hiramoto's experimental results.

Key words active microfilament cytokinesis contractile ring big deformation tension

DOI:

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