Formation of tissue aggregation of biological cell

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Understanding biological self-assembly process has many applications. Here we investigate the ability of cells to self-organize and construct cellular aggregates on non-adhesive substrates motivated by some of the experiments [**?**]. Regenerating or repairing damaged or diseased tissues is main motivation for cell self assembly. Examples include liver cirrhosis, kidney insufficiency, and skin burn or cancer, which may require the transplant of portions of or whole tissues to restore the affected organs. Due to the insufficient number of donors for the existing organ transplantation, new strategies of tissue engineering have been developed to produce functional replacement tissue for clinical use and create biological substitutes that restore tissue function. Self-assembly is the autonomous organization of components, from an initial random state into a final pattern or structure without external intervention. The principle behind self-assembly is that molecules will always seek for a lower energy level, for example by bonding with an adjacent molecule.

In our theoretical model cells are deposited on a non adhesive substrate,where the spreading is energetically unfavourable, they diffuse randomly driven by active cell motility and eventually meet to form clusters that compact due to surface tension. In this system, diffusion is the primary transport mechanism for the cells to gather and form aggregates. This process is a specific example of diffusion-limited aggregation [**?**]. In our case, however, aggregates have a surface tension . For constructing the cellular aggregates we build a lattice model of a system of living cells and then turn to simulate its evolution using a rule based probabilistic method [**?**]-[**?**] which describes the interaction between cells based on the differential adhesion hypothesis (DAH) proposed by Steinbe[**?**]. The rule adopted by us is discussed in brief. A empty site on the neighbouring site of the cluster is randomly chosen and allowed to attempt to move to that site of its original position[**?**],[**?**]. The energy i.e., the cell-cell interaction energy can be calculated considering first, second and third nearest meighbours. If the energy of the particle is lower or same in the new site than in the old site the move to this new site is readily accepted; otherwise if the energy is greater the corresponding change of energy ΔE is calculated, and the new conformation is accepted with a probability $\exp(-\Delta E)$. This process continues for a number of iterations, or Monte Carlo steps (MCS).

We investigate the motion of the clusters and how the velocity of the clusters depends on the size of the clusters motivated by experiments[**?**]. Besides constructing the the cellular structures we study the time evolution of the number of clusters. The time evolution of the cellular cluster area is also investigated. In the experiment, the area of a cluster increases at short time by aggregation while the collisions occur and decreases at long time by compaction at longer times. Basically we compare our theoretical model predictions with the observed experimental results.

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