Insalate di Matematica presents

Mathematical modeling of soft matter at small scales

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Soft solids can undergo very large deformations even if they are subjected to relatively small forces. Such a compliant mechanical behaviour is typically encountered for biological media: rearrangement of cells, orgonoids and solid tumors. Moreover, if the lengthscales are compared to the dimension of tissues, some quantities which can be neglected at the continuum level have a predeominant role.

In this talk I would like to present two works releated to my PhD thesis. In the first one, we notice that during the mitotic process from the 8-cells to the 16-cells stage, the *mitotic spindle* in the peripheral cells polarizes along the radial direction of the cellular aggregate. We investigate the mechanical cues driving the three-dimensional packing by exploiting the maximization of the contact surface under the constraint of mass (volume) conservation. By enforcing the mechanical balance, we find that the radial surface tensions are higher than the circumferential ones.
For the second one, we consider the process of gyrification: it is triggered by the inhomogeneous growth of the peripheral region. To describe this phenomenon, we use the theory of morpho-elasticity and we show that the surface energy acting on the boundary is relevant at these small length scales. Moreover, we prove that the lack of brain sulci in the lissencephaly disease is caused by a reduction of the cell stiffness.

Keywords:

mathematical biology • embryogenesis • mechanical instabilities • brain development

"Obvious" is the most dangerous word in mathematics.
- Eric Temple Bell