

Soft Mechanical Programs in the World of Living Cells

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The mechanical properties of cells are becoming recognized as key indicators and control mechanisms during physiological processes such as mitosis, malignant transformations and differentiation. In addition, these properties are also highly responsive and time dependent.

In this talk I will describe recent work utilizing simultaneous atomic force microscopy, traction force microscopy and laser scanning confocal microscopy to investigate dynamic and timescale dependent cell mechanics. In combination with modern molecular biology and physical/computational approaches we examined the transmission of force through living cells resulting in dynamic remodeling of focal adhesions and viscous three-dimensional relaxation of the cytoskeleton.

In turn, the mechanical response of the cell was also observed to be highly regulated by the substrate stiffness. These approaches were then applied to study the programmed mechanical breakdown of the cell during early apoptosis (cell death). Cytoskeletal control of short (<1sec) and long (>1min) term elastic and viscous deformations were quantified and directly linked to the cell death program in a time-dependent manner. Cell mechanics is distinctly controlled by time and cell-type dependent mechanisms which, in turn, are governed by the mechanical micro-environment. The interesting physics is not merely a side-product of biology but is a key component of a biological and physical feedback loop governing the life of a cell.