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High-resolution elasticity maps and cytoskeletal dynamics of neurons measured by combined fluorescence and atomic force microscopy[1]

CRISTIAN STAII, Tufts University

Detailed knowledge of mechanical parameters such as cell elasticity, stiffness of the growth substrate, or traction stresses generated during axonal extensions is essential for understanding the mechanisms that control neuronal growth. Here I present results obtained in my research group, which combine Atomic Force Microscopy and Fluorescence Microscopy measurements to produce systematic, high-resolution elasticity maps for different types of live neuronal cells cultured on glass or biopolymer-based substrates. We measure how the stiffness of neurons changes both during neurite outgrowth and upon chemical modification (disruption of the cytoskeleton) of the cell. We find a reversible local stiffening of the cell during growth, and show that the increase in local elastic modulus is primarily due to the formation of microtubules in the cell soma. We also report a reversible shift in the elastic modulus of the cortical neurons cytoskeleton with temperature, from tubulin dominated regions at 37C to actin dominated regions at 25C. We demonstrate that the dominant mechanism by which the elasticity of the neuronal soma changes in response to temperature is the contractile stiffening of the actin component of the cytoskeleton induced by the activity of myosin II motors.

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