

# **AFM analysis of astrocyte membrane remodeling induced by immunoglobulin G from patients with amyotrophic lateral sclerosis**

A. Jakovljević<sup>1</sup>, D. Bijelić<sup>1</sup>, F. Quiros-Corella<sup>2</sup>, R. Pereira Reyes<sup>3</sup>, J. R. Vega Baudrit<sup>3</sup>, L. Radenović<sup>1</sup>, P. Andjus<sup>1</sup>, Y. R. Corrales Urena<sup>3</sup>

<sup>1</sup>*Center for laser microscopy, Institute for Physiology and Biochemistry “Jean Giaja”, Faculty of Biology University of Belgrade, Belgrade, Serbia*

<sup>2</sup>*Advanced Computing Laboratory, National High Technology Center CeNAT CONARE, San Jose, Costa Rica*

<sup>3</sup>*National Laboratory of Nanotechnology, National High Technology Center CeNAT-CONARE, San Jose, Costa Rica*

e-mail: ana.jakovljevic@bio.bg.ac.rs

This study investigated whether immunoglobulin G (IgG) from Amyotrophic Lateral Sclerosis (ALS) patients induces subcellular and biophysical changes in cultured primary astrocytes. We applied Atomic Force Microscopy (AFM) and Scanning Electron Microscopy (SEM) to evaluate membrane morphology and stiffness in astrocytes treated with ALS or control IgGs, compared to untreated (Naïve) cells. AFM analysis revealed a significant increase in surface roughness and a decrease in Young's modulus following ALS IgG treatment, suggesting membrane remodeling and reduced cell stiffness. High-resolution AFM imaging also revealed structural features suggestive of membrane clustering, perforation, and potential phase separation, specifically in ALS IgG-treated cells. These changes may reflect protein aggregation or lipid domain reorganization, which are consistent with the decreased lacunarity observed in SEM-based fractal analysis. While both ALS and control IgGs increased microvilli area and surface complexity, only ALS IgGs led to significant disorganization of surface texture, as confirmed by texture and fractal analyses. Taken together, these findings demonstrate that ALS IgGs induce distinct and more pronounced alterations in astrocyte membrane biomechanics and organization compared to control IgGs, suggesting a role in early astrocytic dysfunction in ALS.