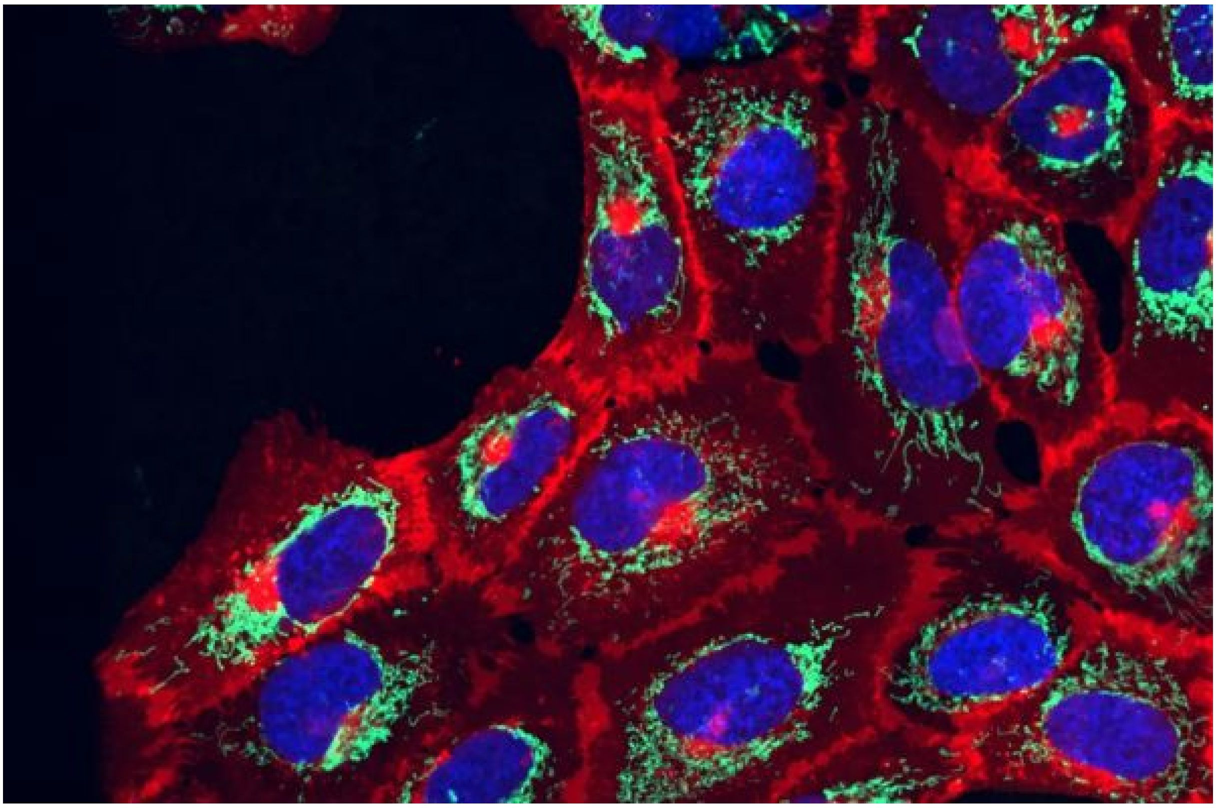

The challenges of studying mechanical properties in cells

In a Nature Nanotechnology perspective article, an international team of researchers highlights the major challenges that the field of mechanobiology currently faces. Addressing these hurdles could improve the analysis, monitoring and prediction of mechanobiological processes, ultimately leading to improvements in biotechnological and medical applications.

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Shape, volume, pressure, tension, stiffness, force, viscoelasticity, adhesion, flow... All thes mechanical properties directly affect our tissues, cells, and cellular components. Cells, fo instance, can feel how rigid their underlying surface is, how their membrane stretches o compresses, or how much pressure other structures exert on them. They then convert thes physical forces and mechanical properties into biochemical signals, triggering differen effects and behaviors that cause the cell to reshape, deform, or migrate to a differen location, among others.

? At the moment, mechanobiology - the field that studies how biological components sens

, interpret, and convert mechanical features into biochemical signals - is facing sever l challenges. Firstly, measuring mechanical properties from the molecular to the cellular lev l requires high precision in both space and time, covering everything from the sub-nanomet r to the centimeter regime and from microseconds to days; a versatility that current tools ha e not yet achieved. Secondly, tools to manipulate and apply these mechanical stimuli t defined magnitudes, locations, times, and rates are also lacking, as well as reference syste s to accurately calibrate them. Finally, understanding how different mechanical paramete s affect each other and how they interact with other biological and physiological parameters s essential for building accurate theoretical frameworks. Current models, in contrast, tend o oversimplify and typically lead to discrepancies when interpreting the result . All these challenges have now been comprehensively presented in a Nature Nanotechnology perspective article, co-led by **ICFO Prof. Michael Krieg**. The article combines the efforts of several experts in mechanobiology from institutions across the globe, including the ETH Zürich, the University of California, the Institute for Bioengineering of Catalonia (IBEC), th Institute of Human Biology (IHB), the Friedrich Miescher Institute for Biomedical Researc (FMI), the Max-Planck-Institute for the Physics of Complex Systems, the Center for System Biology Dresden, PSL University, the Swiss Institute of Bioinformatics, the Ecol Polytechnique Federale de Lausanne (EPFL), the University of Basel, and the University o Glasgow

Together, the team has identified the key aspects that must be systematically tackled in orde to deepen our understanding of the mechanical attributes of biological samples. ï¿?We believe that our insights can guide future research in mechanobiology, helping us decip er how complex cellular systems sense, respond to, and apply mechanical cues,ï¿½ says Pro . at ICFO Michael Krieg, one of the first co-authors of the article. ï¿½To do so, chang ng our approach from reductionistic to holistic is key,ï¿½ he stresses. According to the authors, successfully addressing the presented challenges could, in turn, lead to si nificant improvements in several biotechnological and medical appl

Reference:

Kashuba et al. Advancing mechanobiology from single molecules to complex cellular systems. Nature Nanotechnology, 2026.
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