Institute for Bioengineering of Catalonia

Speaker @
PARALLEL SYMPOSIUM
**Mechanobiology in regenerative medicine**

SEMIT

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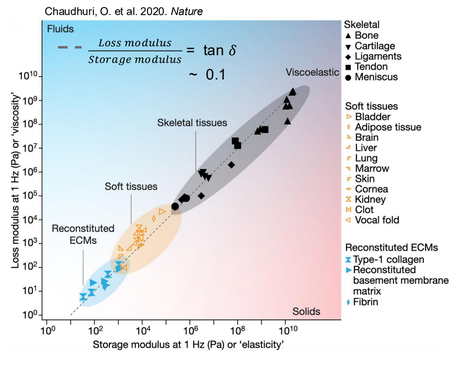
# Mechanotransduction of soft matrix viscoelasticity in stem cells and neurons


Mariana A. G. Oliva[1,2], Manuel Salmeron-Sanchez[1,2,3]

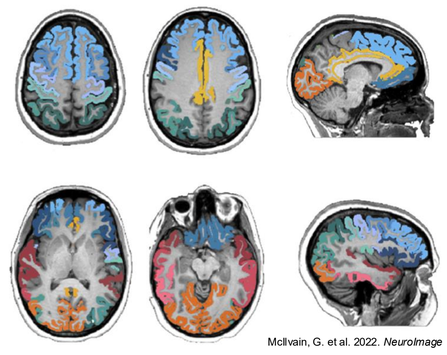
*1 Institute for Bioengineering of Catalonia (IBEC), The Barcelona Institute for Science and Technology (BIST), Spain; 2 University of Glasgow, UK 3 Institució Catalana de Recerca i Estudis Avançats (ICREA), Spain*

mazevedo@ibecbarcelona.eu


## INTRODUCTION

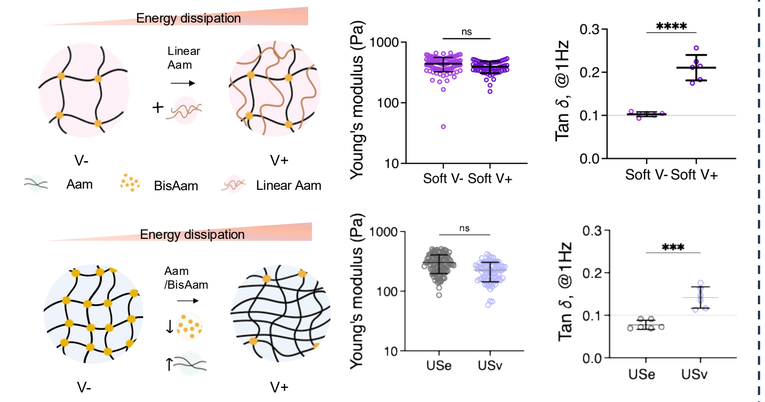



Tissues in the body behave as viscoelastic solids rather than purely elastic ones

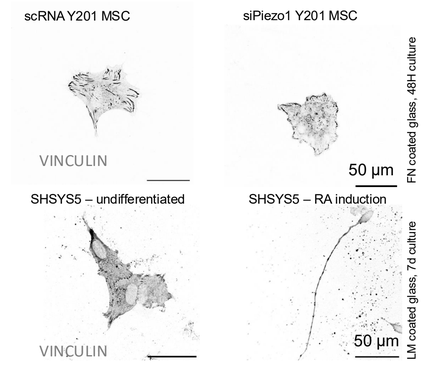



Brain tissue is particularly viscoelastic, and different regions have specific viscoelastic signatures

## MATERIALS & METHODS



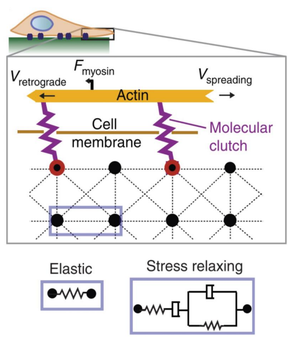

Soft PAAm hydrogels where energy dissipation can be controlled via two approaches

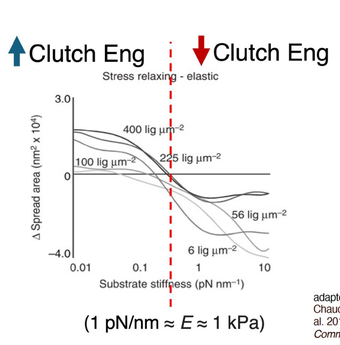



Cell models for stem cell and neural studies

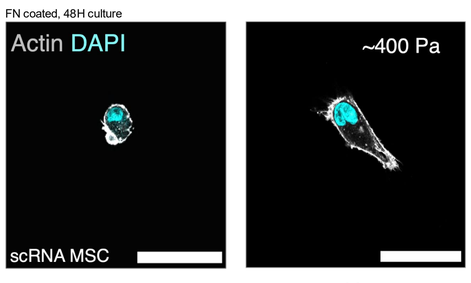
## RESULTS

**1** Our previous work using Mesenchymal stem cells showed that Piezo1 modulates cell response to soft matrix viscoelasticity through the molecular clutch

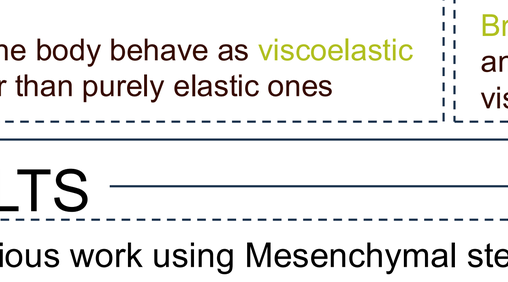


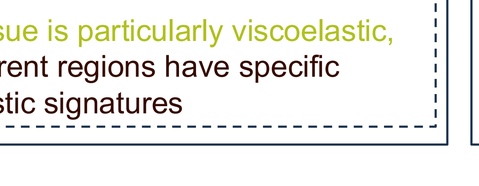




adapted from Chaudhuri, O. et al. 2015. *Nature Communications*

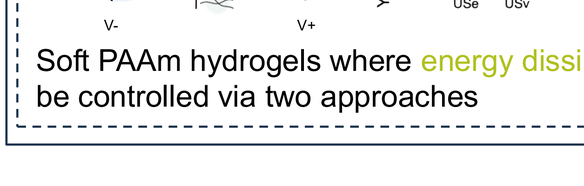


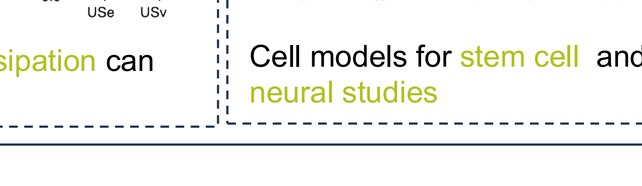

Computational model implementation and parameters



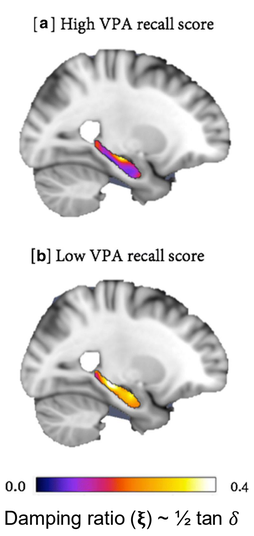

adapted from A. G. Oliva, M. et al. 2025. *Nature Communications*



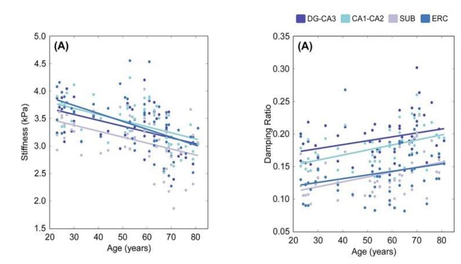




By modifying the molecular clutch model to include the crosstalk between integrins and Piezo1, we established a mechanistic understanding of how Piezo1 modulates the mechanotransduction of viscoelasticity in soft ECMs **2**

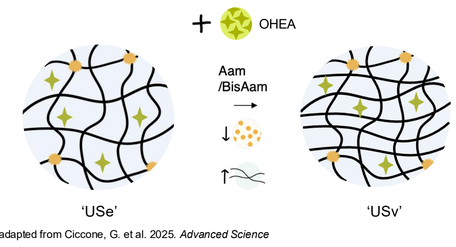
**3** Given the highly viscoelastic nature of brain tissue, we sought to investigate neuronal activity in physiological and pathological contexts by chemically adapting our hydrogel platform



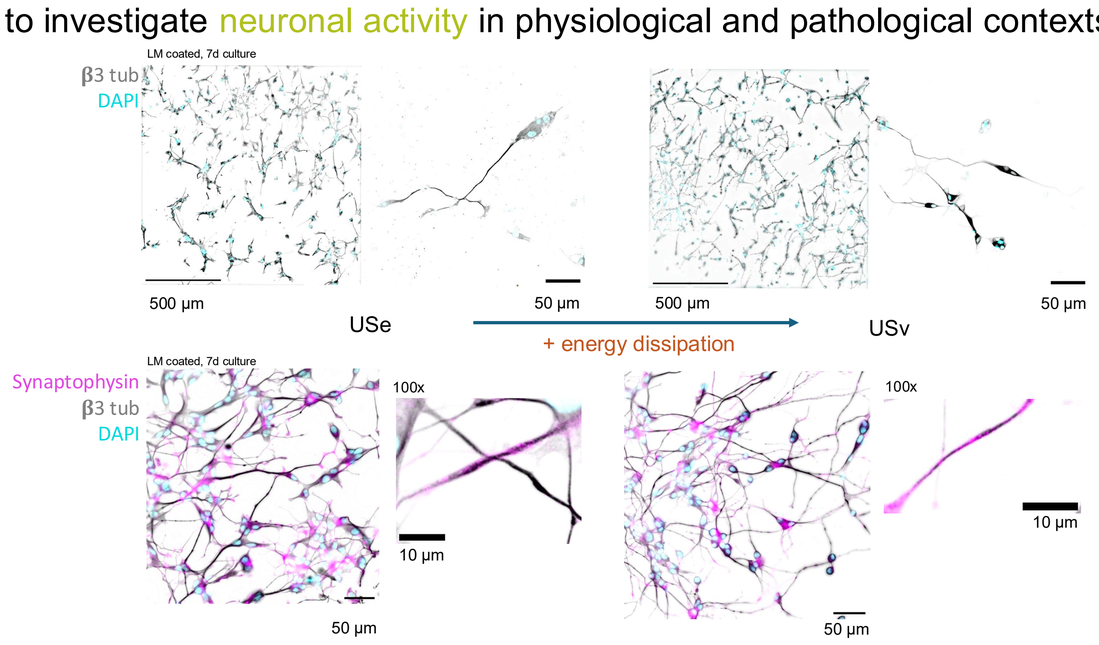

adapted from Hiscox, L. et al. 2020. *Brain Imaging and Behaviour*

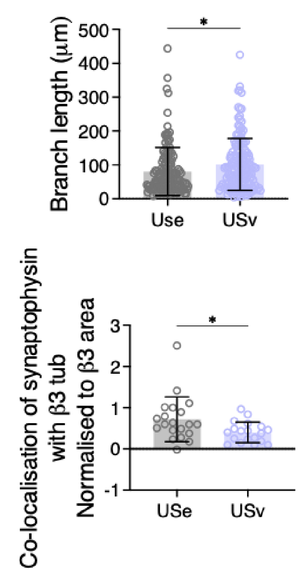



adapted from Delgorio, P. et al. 2021. *Cerebral Cortex*




adapted from Ciccone, G. et al. 2025. *Advanced Science*




From preliminary data with SHSYS5 derived neurons, neurite growth and activity appears to be viscoelasticity-dependent, suggesting that there might be scope to investigate the role of viscoelasticity (and potentially Piezo1) in neurological disease progression mechanisms **4**

## CONCLUSIONS

Our previous work investigated the Piezo1-dependent mechanisms of soft viscoelastic matrix mechanotransduction

Given the highly viscoelastic nature of brain tissue, we suggest a mechanistic framework for Piezo1's involvement in neural tissue physiology and pathophysiology

In preliminary results, neuronal growth and activity are sensitive to matrix viscoelasticity, proposing a mechanosensitive mechanism for neural network formation

## REFERENCES AND AKNOWLEDGEMENT


Publications:

*A. G. Oliva, M. et al. 2025.* ***Piezo1 regulates the mechanotransduction of soft matrix viscoelasticity.*** *Nature Communications*

*Ciccone, G. 2025.* ***Epithelial cell mechanoresponse to matrix viscoelasticity and confinement within micropatterned viscoelastic hydrogels.*** *Advanced Science*

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*Chaudhuri, O. et al. 2020. Effects of extracellular matrix viscoelasticity on cellular behaviour. Nature.*

McIlvain, G. et al. 2022. Mapping brain mechanical property maturation from childhood to adulthood Author links open overlay panel. *NeuroImage*

*Chaudhuri, O. et al. 2015. Substrate stress relaxation regulates cell spreading. Nature Communications.*

Hiscox, L. V. *et al.* 2020. Hippocampal viscoelasticity and episodic memory performance in healthy older adults examined with magnetic resonance elastography. *Brain Imaging and Behavior*

Delgorio, P. L. *et al.* 2021. Effect of Aging on the Viscoelastic Properties of Hippocampal Subfields Assessed with High-Resolution MR Elastography. *Cerebral Cortex*



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EXCELENCIA SEVERO OCHOA

bist