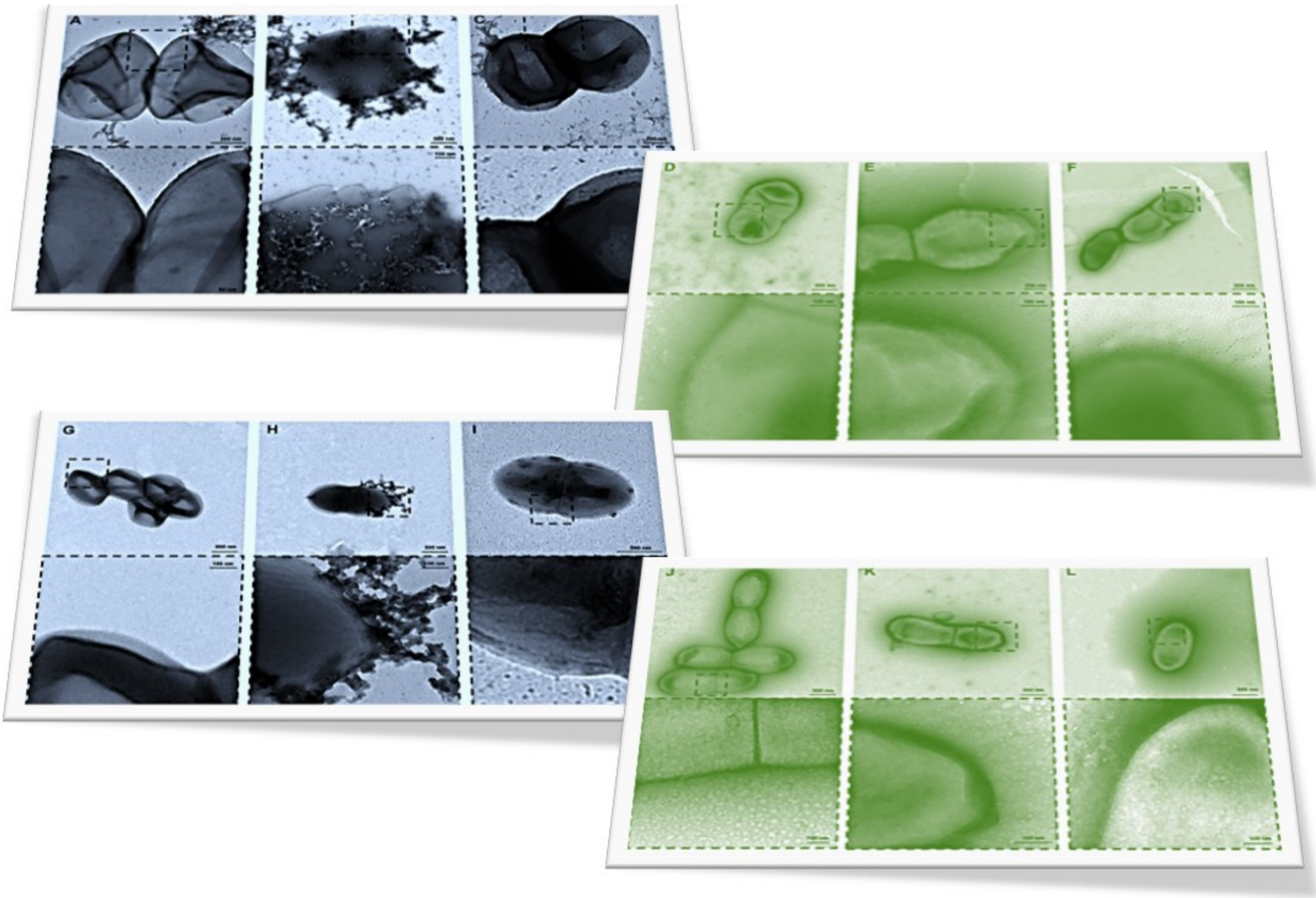
BOKU UNIVERSITY

2025 Annual Report

Institute of Biophysics

Universität für Bodenkultur Wien



2025 Annual Report

Institute of Biophysics

Universität für Bodenkultur Wien, Austria

Foreword

2025 was the first year in the new department, a bit of a dark-horse beginning. This year I read several books on corporate structure and governance, and they were right: restructuring often brings loss of resources and budget cuts. That is what happened to us. Was it good to join the new department? We will see in a couple of years. Right now, we lost positions, funding, and physical space. We are not the only ones in this situation. With the new structure, we have lost our direct line of communication with the rectorate. It feels like being a nowhere man in a nowhere land.

Alright, let us set the complaints aside and focus on what is going well. We have to keep moving forward. Time passes quickly, and once we're no longer around, companies tend to forget fast.

Was 2025 a good year? Yes, it certainly was.

At the local level, we continued our tradition of hosting our small biophysics breakfast, where we invited nice guests, such as the astronomer Álvaro Hacar, who explained how molecules can be detected in distant regions of space, and the chemist Grzegorz Celichowski, who reminded us that nanofabrication is far from trivial. We also celebrated the completion of bachelor (A. Schäfer), master (K. Noulis) and PhD projects (G. Tiloca). We also managed to organize the institute's fourth habilitation (J. Dostalek), to be defended during 2026. In addition, we welcomed several visitors at different academic stages, from professors to Erasmus students. This openness has become part of our identity, and we will continue to welcome researchers from both national and international backgrounds, sharing our expertise and keeping our doors open to new ideas. A standout moment was the visit from 47 students of the secondary school IES Diego Tortosa (Cieza, Murcia) on December 15. Yeah, definitely, cold chaos exists.

As in previous years, 2025 was an excellent one for us. We published 22 articles and we contributed to 21 conferences, workshops, seminars, and outreach events. We also assisted in organizing two scientific meetings. In addition, we took part in evaluating international PhD theses and research proposals. Importantly, we secured funding (primarily from the FWF and OeAD) to support young researchers doing their PhD Thesis.

The future stretches before us in a haze of uncertainty, much like Nature itself. Within ILK (meeting of the head of institutes), we remain a minority, and the redistribution of resources in the coming years will be decisive for our development. As a young institute, barely 15 years old, we continue to introduce fresh perspectives and new topics to BOKU; that is, after all, why the institute was created. And we will fulfill that purpose. Periods of change always bring opportunities for reinvention, inviting us to evolve into something greater than we were before.

Finally, I want to express my deepest gratitude to everyone who supported us throughout 2025 with their hard work, dedication, and good mood. Thank you, and good night. Tomorrow never knows (part two).

Jose L. Toca-Herrera

Institute members and visitors

- Univ. Prof. Dr. José L. Toca-Herrera (director)
- Dr. Wisnu Sudjarwo (Univ. Assistant, deputy director)
- Assoc. Prof. Dr. Notburga Gierlinger (group leader)
- Dr. Jessica Huss (research associate, PI)
- Dr. Lukas Schrangl (Univ. Assistant)
- Dr. Tiziana Fresu (secretary)
- Mag. Amsatou Andorfer-Sarr (technical assistant)
- MSc. Paraskevi Charalambous (technical assistant)
- Mag. Jacqueline Friedmann (technical assistant)
- Mag. Valerie Wagner (technical assistant)
- MSc. Alexander Einschütz Lopez (PhD student)
- MSc Florian Gregor (PhD Student)
- MSc. Yudho Harjoyudanto (PhD student, OeAD grant)
- MSc. Mahder Mekonnen (PhD student, OeAD grant)
- MSc. Luis Ponce-Gonzalez (PhD student)
- MSc. Giuseppe Tiloca (PhD student)
- BSc Konstantinos Noulis (MSc student)
- BSc Florentina Stadlbauer (MSc student)
- BSc Ansgar Schäfer (MSc student)
- Manuela Forthuber (BSc student)
- Konstantinos Kounetas (apprentice)
- Assoc. Prof. Rafael Benitez Suarez (University of Valencia)
- Prof. Grzegorz Celichowsky (CEEPUS program)
- Dr. Thibaud Messerschmid (LMU Munich)
- Dr. Maria dM Vivanco (CIC bioGUNE)
- MSc Tommi Bui (PhD student, collaboration LMU Munich)
- MSc. Marilou Camboué (PhD Student, collaboration INRAE Bordeaux)
- DI Sarah Celine Suarez (PhD student, collaboration BOKU)
- MSc Guillem Coll (Erasmus PhD student, collaboration UIB)
- MSc. Magdalena Osowiecka (PhD student, collaboration Univ. Vienna)
- MSc. El Medhi Raoui (PhD student, collaboration Univ. Vienna)
- MSc. Steffen Tripmacher (PhD student, collaboration with Bayreuth University)
- DI Matthias Weinberger (PhD student, collaboration BOKU)
- DI Maja Vasiljevic, (PhD student, collaboration BOKU)
- BSc Carlota Burriel (Erasmus MSc student, CEU San Pablo)
- BSc Giovanni Lessio (Erasmus MSc student, Univ. of Milan)
- BSc Carolina Seideman (Erasmus MSc student, CEU San Pablo)

Note: On December 15, a group of 47 students from IES Diego Tortosa in Cieza (Murcia) visited the Institute of Biophysics at BOKU.

Research projects

Biomechanical Softening of Vero Cells Induced by Measles Vaccine Virus

A. Einschütz Lopez[1], *J. Bacher*[2], *J.L. Toca-Herrera*[1]
[1]Institut für Biophysik, NWNR, Universität für Bodenkultur Wien, Austria
[2]Institut für Bioverfahrenstechnik, DBL, Universität für Bodenkultur Wien, Austria

Objective

To quantify early biomechanical changes in Vero cells after exposure to a measles vaccine virus (MVV) using atomic force microscopy (AFM) and confocal microscopy.

Results & Conclusion

Main findings: High-dose infection (MOI 0.5) produced pronounced, dose-dependent softening (≈35% reduction in median Young's modulus) and altered viscoelasticity (lower relaxed modulus, changes in viscosities and increased fluidity), whereas low-dose infection (MOI 0.1) showed negligible mechanical change.

Cytoskeletal correlate: Mechanical softening coincided with actin remodelling—loss of internal stress fibbers and formation of dense cortical actin rings—similar to effects induced by cytochalasin D treatment.

Implication: AFM-based biomechanical profiling provides a rapid, label-free complement to biochemical assays and could be useful for early detection of infectious virus activity, bioprocess monitoring, or vaccine quality control.

Pictures/Figures

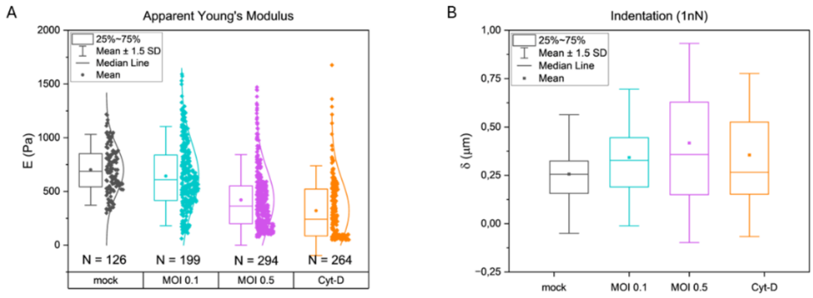


Figure 1. Influence of treatment on the apparent Young's modulus (A) and the indentation at 1nN force (B) on measurements performed in Vero cells cultured on glass-bottom petri dishes. An indentation depth of 500 nm was evaluated to obtain the young's modulus. Box plots represent the data from the first to the third quantile with the whisks being 1.5x de standard deviation. Central point represents mean values and the black line represents the median. For the Young's modulus all comparisons except from Control MOI 0.1 are statistically significant ($p < 0.001$), for the indentations all treatments are significant compared to mock ($p< 0.05$)

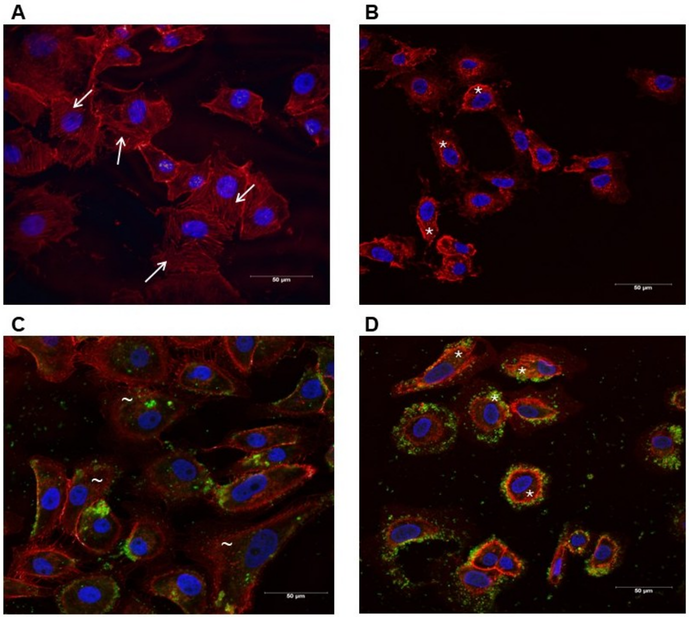


Figure 2. Fluorescence images of Vero CCL-81 cells stained with Phalloidin, showing actin (red); DAPI, showing cell nuclei (blue) and measles virus F-antigen (green) under different conditions. Non-infected cells (A) were used as negative control showing an intact cytoskeletal structure with thick F-actin bundles which are indicated by the white arrows, spanning the cell body. Cytochalasin D treated cells (B) were used as positive control display disrupted F-actin organization, loss of stress fibers and shrunken cell bodies (*). Cells infected with MVV at MOI 0.1 (C) show partial cortical accumulation of F-actin with residual internal stress fibers and focal adhesions marked with ”~” to show affected cells, indicating cytoskeletal remodeling. Cells infected with MVV at MOI 0.5 (D) show actin fibers predominantly redistributed to the cell periphery, forming cortical actin rings with a notable absence of internal stress fibers and shrinked cell bodies (*). Scale bar: 50 µm.

Funded by Austrian Science Fund (FWF) 10.55776/P35777

Measuring colloidal and molecular forces with AFM: media influence on hydrophobic interactions

L. N. Ponce-Gonzalez[1], *J. L. Toca-Herrera*[1]

[1]Institut für Biophysik, Universität für Bodenkultur Wien. Muthgasse 11, 1190 Wien, Austria

Objective

Hydrophobic interactions govern key colloidal and molecular processes such as self-assembly, aggregation, and protein folding. The objective of this study is to investigate the mechanism of the hydrophobic effect in different media conditions. For this aim, hydrophobic surfaces will be prepared using chemical vapour deposition (CVD) of fluorocarbons and characterized with electronic microcopy, zeta potential and contact angle. Furthermore, atomic force microscopy (AFM) will be used to acquire force–distance curves between the prepared surfaces, which will be analysed using extended electric double-layer (EDL) and van der Waals (vdW) models to interpret the measured interactions.

Results & Conclusion

In this project, we examined how salt and solvent influence molecular and colloidal forces between hydrophobic surfaces using AFM. Force–distance measurements (approaching segment) showed that all colloidal systems exhibited long-range electrostatic repulsion that weakened with increasing salt concentration, followed by a steep short-range hydration repulsion (Figure 1). Hydrophobic interactions showed a consistent short-range jump-in of ~4 nm independent of salinity. Fitting experimental data demonstrated that classical DLVO theory is insufficient even for simple modified substrates, requiring extended models incorporating van der Waals, electrostatic, hydration, and hydrophobic contributions to extract parameters such as surface potential, Debye length, the Hamaker constant, and hydrophobic decay length. Further experiments on molecular systems (Figure 2) confirmed that hydrophobic interactions are longer-ranged and stronger than theoretical vdW forces. Both vdW and hydrophobic attractions weaken as solvent polarity decreases in water:DMSO mixtures. Moreover, a comparison between AFM pull-off forces and contact-angle sessile-drop measurements demonstrated consistent trends in hydrophobicity, with adhesion force and contact angle increasing with water molar fraction (Figure 3). These experiments also provided an improved method for the determination of critical surface tension with a modified Zisman plot. Based on these findings, future work will explore the media influence on the mechanical unfolding of proteins.

Pictures/Figures

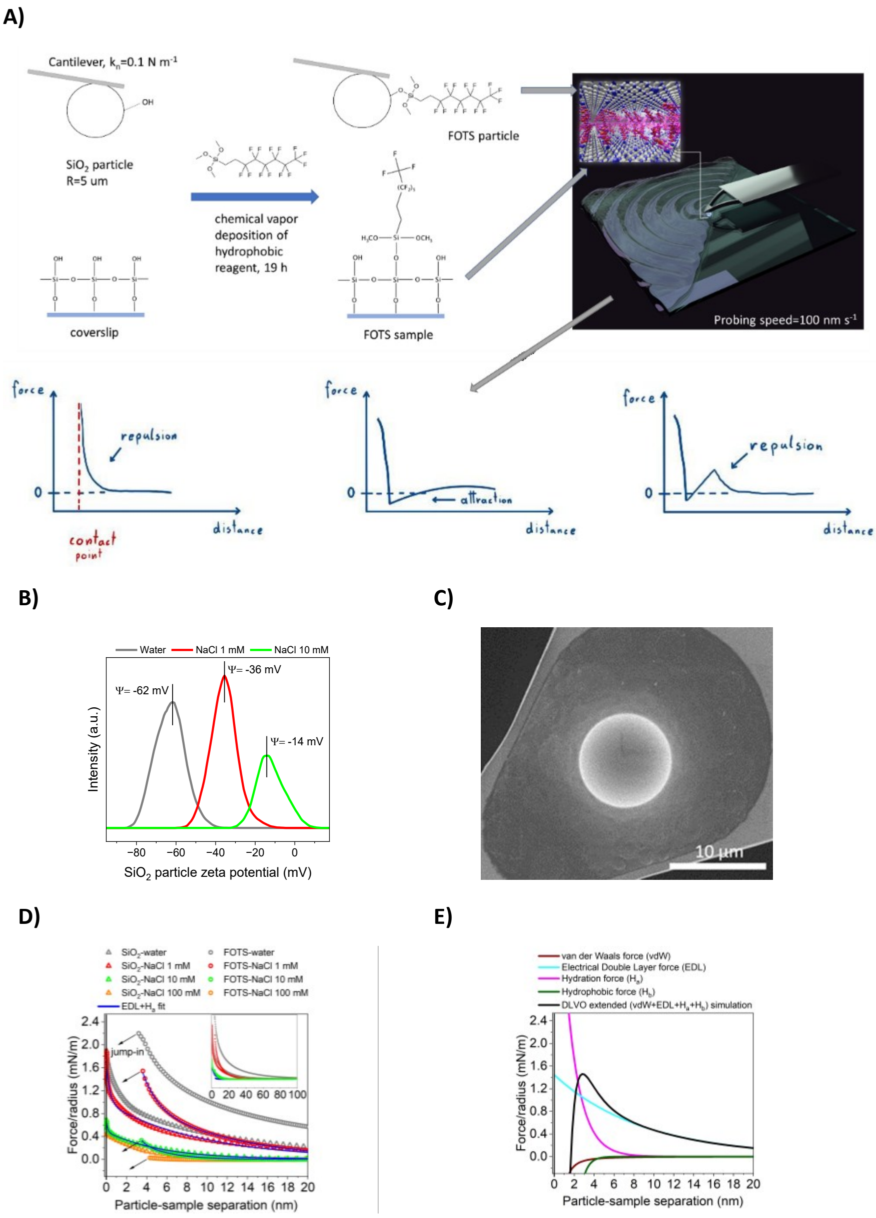


Figure 1. Abstract of the salt influence on colloidal interactions featuring the preparation of fluorocarbon surface on silica (A), characterization by zeta potential (B) and SEM (C) of silica particles, results of force-distance measurements (D) and extended DLVO model simulations (E).

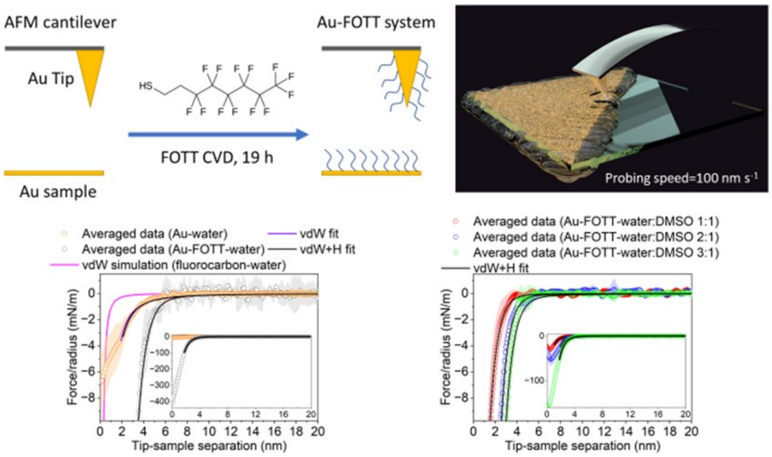


Figure 2. Abstract of the solvent influence on molecular interactions featuring the preparation of fluorocarbon surface on gold and the results of force-distance measurements.

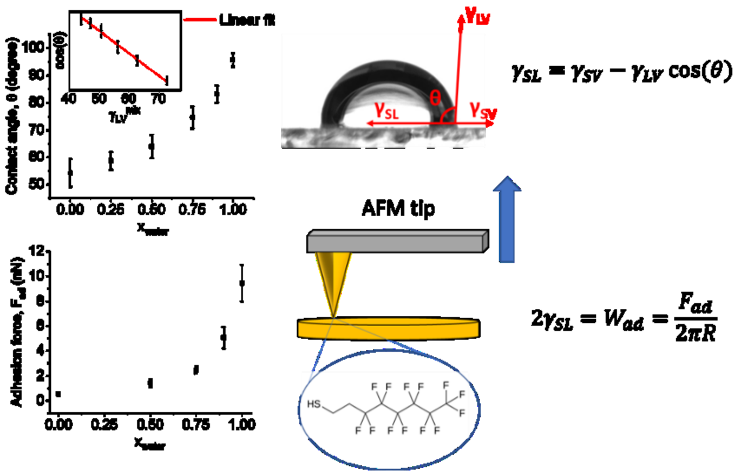


Figure 3. Abstract of the determination of solid-liquid interfacial tension of fluorocarbon using aqueous solvent binary mixtures (water-DMSO) comparing AFM and contact angle techniques.

Funded by Austrian Science Fund (FWF) 10.55776/P35777

Original publication: Microscopy Research and Technique, doi: 10.1002/jemt.70111**;** Microscopy Research and Technique 88 (2025) 1626, doi: 10.1002/jemt.24832

Single-molecule FRET measurements of T cell receptor-exerted mechanical forces and bond lifetime estimation

L. Schrangl[1, 2], F. Kellner[3], R. Platzer[3], V. Mühlgrabner[3], P. Hubinger[3], J. Wieland[4], R. Obst[4], J. L. Toca-Herrera[1], J. B. Huppa[3], G. J. Schütz[2], J. Göhring[2, 3]

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[2]Institute of Applied Physics, TU Wien
[3]Institute for Hygiene and Applied Immunology, Center for Pathophysiology, Infectiology and Immunology, Medical University of Vienna
[4]Institute for Immunology, Biomedical Center, Medical Faculty, Ludwig-Maximilians-Universität München

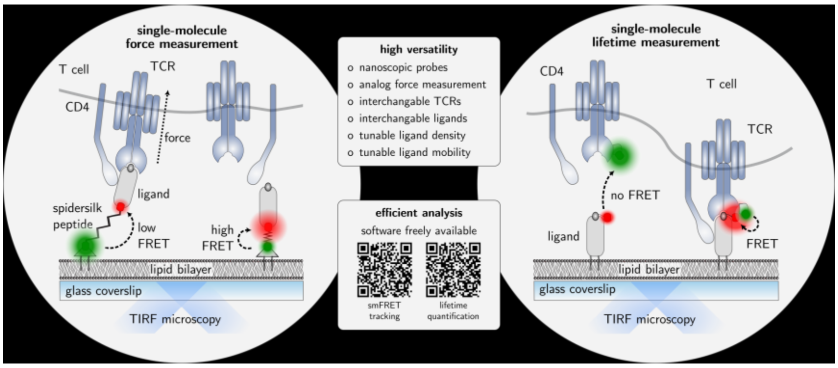
Objective

Mechanical forces acting on ligand-engaged T-cell receptors (TCR) have previously been implicated in T-cell antigen recognition and ligand discrimination, yet their magnitude, frequency, and impact remain unclear. Here, we quantitatively assess forces across various TCR:pMHC pairs with different bond lifetimes at single-molecule resolution, both before and during T-cell activation, on platforms that either include or exclude tangential force registration.

Results & Conclusion

CD4 + T-cell TCRs experience significantly lower forces than previously estimated, with only a small fraction of ligand-engaged TCRs being subjected to these forces during antigen scanning. These rare and minute mechanical forces do not impact the global lifetime distribution of the TCR:ligand bond. We propose that the immunological synapse is created as biophysically stable environment to prevent pulling forces from disturbing antigen recognition.

Pictures/Figures



Funded by Austrian Science Fund (FWF) project 10.55776/P32307-B

Original publication: Nature Communications 16 (2025) 7577, doi: 10.1038/s41467-025-62104-2

Quantifying the effect of temperature on T cell activation via single-cell analysis of calcium signaling

C. Kopittke[1], J. L. Toca-Herrera[2], G. J. Schütz[1], M. Brameshuber[1], L. Schrangl[2]

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[2]Institut für Biophysik, Universität für Bodenkultur Wien. Muthgasse 11, 1190 Wien, Austria

Objective

Influx of calcium into the cytosol is characteristic of early T cell activation. Thanks to the availability of calcium-sensitive dyes, this can be conveniently monitored via fluorescence microscopy. We want to investigate the response of T cells to hypo- and hyperthermic conditions, the latter being present, for instance, during fever.

Results & Conclusion

We developed novel analysis methods which allow us to quantify an extensive set of biophysically relevant parameters from single-cell time traces. Application of said methods to data recorded at different temperatures yielded new insights into the dose-dependent response of T cells to antigen at different temperatures. A manuscript for submission to a specialized journal is currently in progress.

Mechanistic investigation of the glycocalyx

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[2]Institut für Molekulare Biotechnologie, Universität für Bodenkultur Wien. Muthgasse 18, 1190 Wien, Austria

Objective

The glycocalyx is a soft layer of glycosylated biomolecules covering the surface of cells. It can present a mechanical barrier which cells need to overcome in order to interact with each other. As the foundation for future work, we want to quantitate the glycocalyx from a mechanical point of view, by measuring its height, stiffness, and viscosity.

Results & Conclusion

We are currently developing atomic force microscopy-based experimental approaches that will permit precise characterization of the glycocalyx of various epithelial cell lines. For the future, we plan to focus on investigating immune-surveilling cells and their target cells, as such cell-cell interactions and the barriers they encounter are pivotal for the initiation of correct immune responses. This will be accompanied by the development of efficient computer-aided analysis methods.

Rheological Properties and Microstructures of DPPC/POPC Monolayers

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Objective

This study aims to investigate how lipid composition, molecular packing, and interfacial conditions shape the structural and mechanical behavior of lipid monolayers. By combining π–A isotherms, dilatational rheology, and AFM imaging, we seek to link monolayer structure with its elastic and viscoelastic response.

Results & Conclusions

Analysis of π–A isotherms, dilatational rheology, and AFM imaging reveals that lipid monolayers display composition-dependent structural and mechanical behavior. DPPC forms tightly packed, highly reversible monolayers with minimal hysteresis, while increasing POPC content disrupts packing and enhances energy dissipation. AFM images confirm domain formation consistent with LE–LC transitions, supporting the isotherm data. Rheological measurements show that lipid composition, surface pressure, and oscillation conditions strongly influence elastic and viscoelastic responses, with Lissajous plots clearly distinguishing linear from nonlinear deformation. Together, these results demonstrate how molecular packing governs both the structure and dynamic mechanics of lipid monolayers.

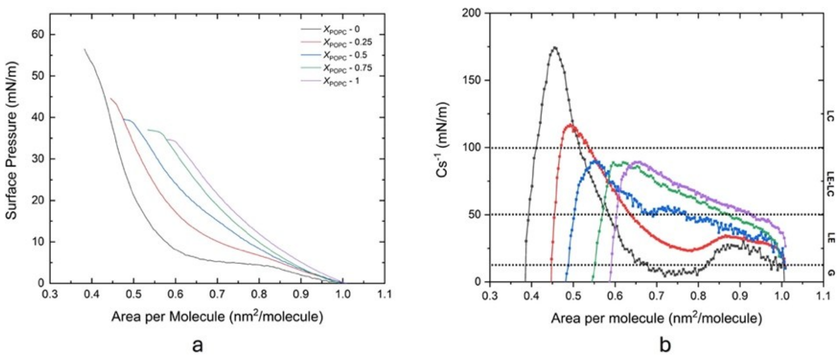

Figure. (a) Surface pressure (π)–area (A) isotherms for different DPPC/POPC mixtures and (b) compression modulus (Cs^{-1}) as a function of surface pressure (π) for monolayers composed of various DPPC/POPC molar ratios. Measurements were conducted at 20 °C on a PBS subphase. Curve colors correspond to the DPPC/POPC mixtures: black (xPOPC = 0), red (xPOPC = 0.25), blue (xPOPC = 0.5), green (xPOPC = 0.75), and purple (xPOPC = 1.0).

Funded by Austrian Science Fund (FWF) 10.55776/P35777

Original publication: Langmuir 41 (2025) 16128, doi: 10.1021/acs.langmuir.5c01269

Oligomer assembl of Bacillus thuringiensis Cyt2Aa2 on lipid membranes reveals a thread-like structure

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K. Srisucharitpanit[1], S.Tharad[4]

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[4]Department of Biology, Faculty of Science, Burapha University, Chonburi, 20131, Thailand

Objective

The aim of this study is to investigate the oligomeric structure of the Cyt2Aa2 toxin w hen interacting with different lipid environments. Specifically, we examine how Cyt2 Aa2 assembles on synthetic lipid membranes and erythrocyte membranes, using SDS -PAGE, AFM, and TEM to characterize the resulting protein complexes and structural motifs. This work seeks to clarify how membrane composition influences Cyt2Aa2 oli gomerization and to provide insights relevant to its mechanism of action on target ce lls.

Results & Conclusions

Incubation of activated Cyt2Aa2 with synthetic lipid membranes and erythrocyte membranes produced distinct oligomeric patterns detectable by SDS-PAGE, consistent with hemolytic activity. AFM imaging revealed fusilli-like structures on POPC monolayers and ring-like assemblies on POPC/Chol mixtures, demonstrating that membrane composition strongly influences the architecture of Cyt2Aa2 complexes. TEM micrographs of erythrocytes showed mixed oligomeric forms, ranging from filamentous assemblies to smaller protein complexes, with nanopores appearing as substructures within the filaments. Together, these findings highlight that Cyt2Aa2 adopts different oligomeric organizations depending on the lipid environment, providing deeper insight into its membrane-disruptive behavior. Further work is needed to elucidate its structural forms in insect target membranes.

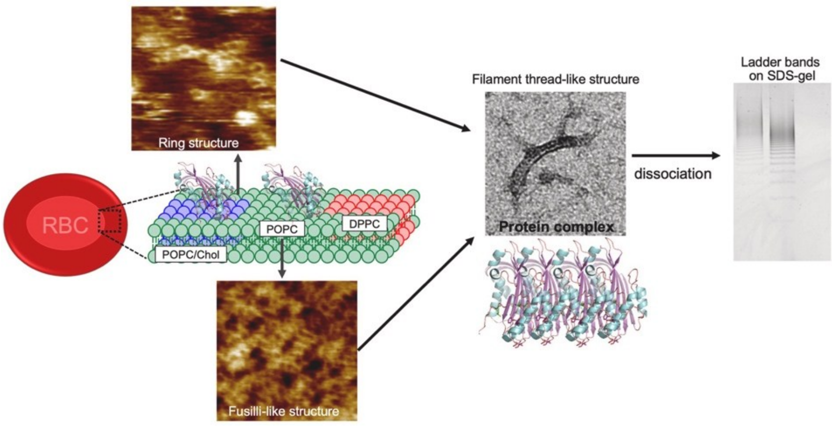

Figure. Cyt2Aa2 toxin forms distinct oligomeric structures depending on the membrane environment. On synthetic lipid membranes, AFM reveals fusilli-like (POPC) and ring-like (POPC/Chol) assemblies, while TEM of erythrocytes shows mixed filamentous and small protein complexes with nanopores as substructures. SDS-PAGE confirms oligomer formation associated with hemolytic activity. Together, these findings demonstrate that membrane composition governs Cyt2Aa2 oligomerization and structural organization.

Original publication: Toxicon X 26 (2025) 100220, doi: 10.1016/j.toxcx.2025.100220

Antimicrobialpeptide plectasin recombinantly produced in *Escherichia coli*disintegrates cell walls of gram-positive bacteria, as proven by transmission electron and atomic force microscopy

M. Müller[1], S. Mayrhofer[2], W. A. A. Sudjarwo[3], M. Gibisch[1], C. Tauer[2], E. Berger[1], C. Brocard[4], J.L. Toca-Herrera[3], G. Striedner[1], R. Hahn[1], M. Cserejan-Puschmann[1]

[1]Christian Doppler Laboratory for production of next-level biopharmaceuticals in E. coli, Institute of Bioprocess Science and Engineering, BOKU University, Vienna, Austria
[2]Institute of Molecular Biotechnology, BOKU University, Vienna, Austria
[3]Institute of Biophysics, BOKU University, Vienna, Austria
[4]Boehringer Ingelheim RCV GmbH & Co KG, Dr. Boehringer-Gasse, Vienna, Austria

Objective

This study aims to produce recombinant plectasin using the CASPON platform and to evaluate its antimicrobial activity and mode of action. To achieve this, we developed a reproducible growth-inhibition assay and used TEM and AFM to characterize structural and mechanical changes in bacteria treated with plectasin.

Results & Conclusions

CASPON-produced plectasin showed strong activity against gram-positive bacteria, while gram-negative strains were unaffected. Electron microscopy revealed structural alterations in treated gram-positive cells, and AFM showed up to a twofold increase in surface roughness and a one-third decrease in stiffness without changes in cell diameter. These statistically supported changes highlight plectasin's impact on the bacterial cell wall. Overall, the results confirm that CASPON enables the production of active plectasin and supports its use for future antimicrobial peptide development.

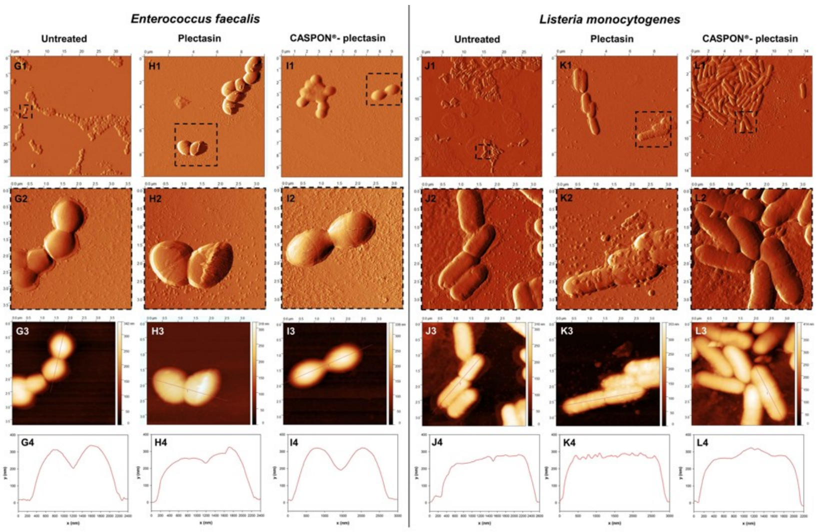

Figure. Atomic force microscopy analysis of the gram-positive bacteria *E. faecalis* (G–I) and *L. monocytogenes* (J–L). For each species, columns 1–3 show untreated, plectasin-treated, and CASPON-plectasin-treated cells, respectively. Row 1 presents overview deflection-error images, while row 2 provides magnified views of the highlighted regions. Row 3 displays height images, and row 4 shows the corresponding topographic profiles derived from these height maps.

Original publication: Journal of Bacteriology 207 (2025) 1,
doi: 10.1128/jb.00456-24 2

Urban water quality management and call for an integrative future: the case of Little and Greater Akaki Rivers

M. Shumi[1,2], M. Elinkmann[3], A. Getahun[4], D. Clases[3], T. Hein[2], J. L. Toca-Herrera[1]

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[3]Department of Analytic Chemistry University of Graz, Austria
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Introduction and Objective

Despite extensive research highlighting severe water quality degradation in the Little and Greater Akaki Rivers, most studies remain site-specific, short-term, and lack integrated spatial and seasonal analyses, leaving pollution hotspot patterns, source contributions, and hydrological seasonal effects insufficiently understood. Existing assessments typically examine each river independently, overlooking their combined downstream impacts and limiting the development of effective management strategies, particularly in relation to initiatives like the Addis Ababa Riverside Development Project.

This study addresses these gaps by conducting a comprehensive spatial and seasonal water quality assessment of both rivers to capture their cumulative effects, strengthen evidence-based river basin management, and support long-term urban river restoration goals, while also drawing on international best practices to propose feasible, context-appropriate management options.

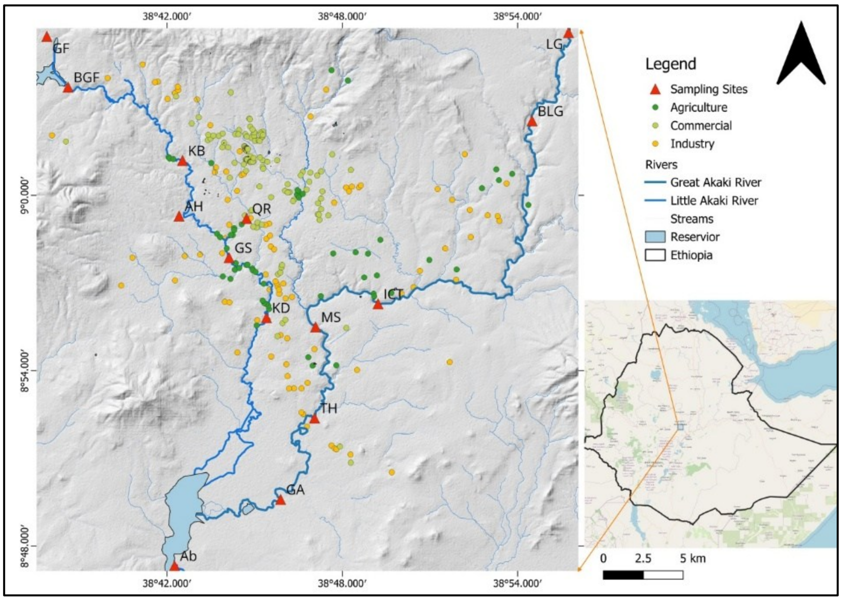

Figure 1. The Akaki watershed map shows sampling site locations along with major land-use activities and potential pollution sources: industries (yellow), agriculture (green), and commercial areas (light green). Triangles mark the sampling sites, and the letters label each site.

Results & Conclusion

Hierarchical cluster analysis identified three distinct groups of sampling sites—reference sites (GF, LG), the site downstream of the Lege Dadi Water Treatment Plant (BLG), and downstream urban sites (QR, KB, ICT, GS, TH, MS, Ab)—each representing different water-quality profiles across the Akaki watershed. Cluster 1 (GF, LG) showed generally low physicochemical, nutrient, and metal concentrations, while Cluster 2 (BLG) was distinguished by elevated Ag, Cr, Hg, and turbidity. Cluster 3 contained three subgroups: KB–QR, characterized by high Fe and Zn; MS–TH–GS–ICT, influenced by higher temperature, TDS, EC, and As; and Ab, the Aba Samuel reservoir, marked by elevated ammonia along with Cu, Cr, and Hg. Although Ab receives combined pollutants from both rivers, measured concentrations were lower than upstream polluted sites, likely because samples were collected after filtration at the outlet, not fully capturing actual reservoir conditions.

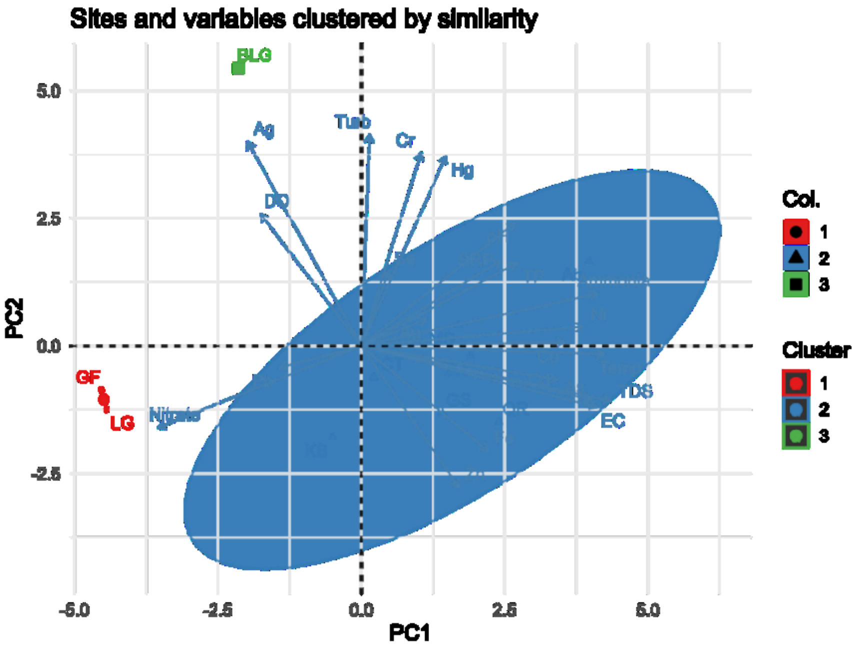

Figure 2. PCA biplot illustrating hierarchical clustering (k = 3) of sampling sites based on physicochemical, nutrient, and metal PCA score values.

Funded by the Austrian Agency for Education and Internationalisation (OeAD).

Exploring the effect of roasting and ultrasound treatment on the emulsifying properties and oxidative stability of flaxseed gum-stabilized oil-in-water emulsions

E. M. Raoui[1], M. Hadidi[1], G. Subbiahdoss[2], J. L. Toca-Herrera[3], H. Peterlik[4], A. Einschütz Lopez[3], M. Pignitter[1]

[1]Institute of Physiological Chemistry, University of Vienna, Austria,
[2]Institute of Colloid and Biointerface science, Department of Bionanosciences, BOKU Vienna, Austria
[3]Institute of Biophysics, Department of Bionanosciences, BOKU, Vienna, Austria, Austria
[4]Faculty of Physics, University of Vienna, Austria

Objective

This study aims to evaluate how microwave roasting of flaxseed, combined with ultrasound-assisted emulsification, enhances the techno-functional and emulsifying properties of flaxseed gum in oil-in-water emulsions, using AFM, cryo-SEM, and SAXS to characterise interfacial and internal microstructures.

Results & Conclusions

Microwave roasting of flaxseed significantly improved the interfacial performance of flaxseed gum, reducing oil–water interfacial tension to 6.42 mN/m compared with 17.44 mN/m for the lecithin control. When paired with ultrasound-assisted emulsification, gum from roasted flaxseed (RS) produced markedly smaller droplets (0.279 µm vs. 1.684 µm for the non-roasted, non-ultrasound sample), along with a higher absolute zeta potential (58.84 mV vs. 38.99 mV), indicating enhanced electrostatic stabilization. Cryo-SEM revealed that RS and ES emulsions formed heterogeneous, dense, and clustered interfacial networks. Shelf-life testing showed that RS emulsions exhibited superior sedimentation stability and delayed lipid oxidation after one month at +4 °C. Overall, combining microwave roasting with ultrasound emulsification substantially improves the emulsifying behavior and oxidative stability of flaxseed gum, demonstrating its strong potential as a natural emulsifier for food applications.

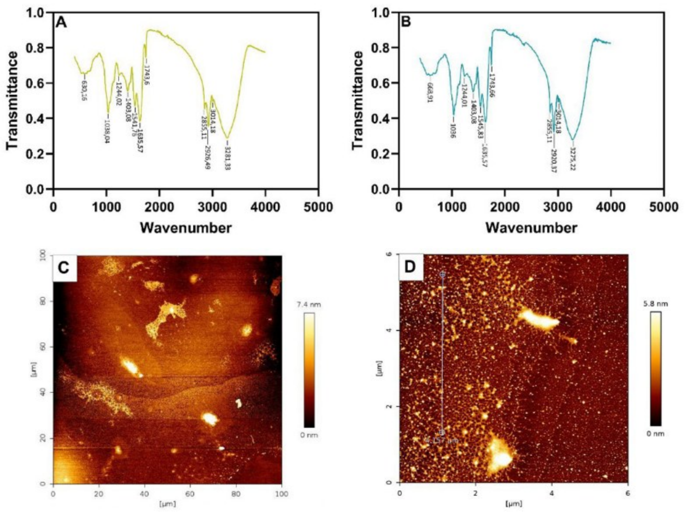

Figure. FTIR spectra and AFM images of the extracted gum from non-roasted (A, C) and roasted (B, D) flaxseed.

Original publication: Future Foods 12 (2025) 100777
doi: 10.1016/j.fufo.2025.100777

Adaptations for fog and dew harvesting in cactus spines

J. C. Huss[1], M. Grömmer[1]

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Objective

Cacti are native to the New World and show distinct adaptations that allow them to survive even in the driest deserts of the world. A characteristic feature of cacti is the formation of spines instead of leaves, which are commonly known as mechanical defence. Interestingly, some species are able to harvest fog and dew with their spines. A basic understanding of the structure and biochemistry of water harvesting cactus spines is still largely lacking. Therefore, this project aims at investigating the anatomy, biochemistry and water interactions of different spines systematically to understand how cactus spines contribute to water collection in arid regions.

Results & Conclusion

Some species utilize spines with porous surfaces that absorb water and transport it within the spine by capillary forces, whereas others show hydrophobic and continuous surfaces. This suggests that at least two fundamentally different types of cactus spines exist for water harvesting: 1) porous spines with internal water transport, and 2) non-porous spines with surface transport.

Pictures/Figures

Figure. Spine of *Copiapoa* after exposure to fog. © Huss/Grömmer, Institute of Biophysics, BOKU Vienna

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Plant cuticle investigation on the micro and nano-scale and its environmental adaptations

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Objective

This research unravels how alpine plant leaf cuticles (the outermost layer) function as dynamic surfaces, enabling resilience under harsh abiotic and/or biotic stressors by using both long adaptation and acclimation strategies. Using Raman microspectroscopy as the central methodological technique, the project develops across four studies, that together aim to build the view of the cuticle as a structure-chemistry-function continuum.

The first study seeks to resolve the fine-scale organisation of cuticle components within a single leaf, including specialised structures such as stomata and trichomes, to determine how spatial chemical heterogeneity contributes to adaptation. Building on these insights, the second study investigated how local microclimates, such as contrasting slope aspects on an alpine mountain, influence cuticle thickness, chemical composition, and functional traits like leaf minimum conductance (g_{min}). A further objective was to compare the cuticles of seedlings and mature conifers at the treeline, exploring how developmental stage and species-specific strategies shape cuticle architecture and whether seedlings (exposed to warmer ground-level temperatures) developed distinct structural or chemical features (third study). Finally, an experimentally prolonged heat exposure was applied to observe induced cuticle plasticity in conifer seedlings, assessing whether experimentally heated plants show acclimation in their cuticle while allowing for thermal stability and water-loss resistance (fourth study).

Overall, the main objective is to reveal how the alpine cuticles function as a dynamic surface that both record environmental conditions and adjust to ongoing stress, thereby playing a central role in the survival and ecological strategies of alpine plants.

Results & Conclusion

Through the first study, Raman microspectroscopy enabled *in situ* chemical mapping of the cuticle at high spatial resolution and resolved its composition (lipids, phenolics, and other secondary metabolites). The ability to decompose hyperspectral maps into spatially resolved, spectral component maps allowed the research to show heterogeneity not only between plant species but also within individual leaves. Adaxial and abaxial surfaces of the alpine shrub *Kalmia procumbens* showed a multilayered structure where cutin, phenolic and triterpenoid differentially distributed. Ursolic/oleanolic acid represented triterpenoids, while flavonoids (flavonols) and anthocyanins characterized the adaxial side, and coumaric acid prevailed on the abaxial side. While triterpenoids are components known for their thermal stability, flavonoids vary in their structure and consequently in functionalities, ranging from UV protection to biotic defence, and water permeability. These chemical adaptations underpin how leaves mediate survival and thriving of plant species in alpine harsh environments, the intricate interplay of cutin, phenolic, and triterpenoid distribution within the cuticle exemplifies the structure-chemistry-function continuum critical for alpine plant survival.

The fine-scale chemical heterogeneity resolved in the first study provided the basis for investigating how these chemical adaptations manifest at a broader ecological scale. Therefore, the second study investigated cuticle structure, chemistry, and functionality at two contrasting slopes (north vs. south). Thinner cuticles (11 µm), such as those found on the northern slope, were enriched in flavonoids (flavonols), and exhibited higher g_{min} if compared to southeastern-facing cuticles, that were thicker (16µm) and with less flavonoids. Cuticles from both sites showed also triterpenoids (ursolic/oleanolic acid). These patterns demonstrated that cuticle traits reflect local microclimates: in warmer, drier conditions (southeastern slope) thicker, and less aromatic cuticles reduced water loss; in cooler and moister habitats thinner, and more aromatic cuticles were effective against fungal infestation, but led to more water escaping the matrix. The role of triterpenoids in cuticle confirmed their role in protecting the matrix against high temperatures, due to their high melting point.

A similar pattern emerged in the third study when comparing conifer seedlings and mature from 3 species: a deciduous (*Larix decidua*) and two evergreens (*Picea abies*, *Pinus cembra*). Mature conifer needles invested in thicker cuticles with external crystalline epicuticular waxes, a trait consistent with their long leaf lifespan and exposure to winter desiccation. Seedlings, which naturally experience higher ground-level temperatures, developed unexpectedly thinner cuticles, but with a comparable chemical architecture to the mature counterparts. Although lacking the epicuticular wax layer, seedling cuticles incorporated waxes and flavonoids (Kaempferol) in a thin transition cuticle layer. Following it, the outer epidermal cell wall layer was dominated by phenolic components (Kaempferol, cinnamic acids). As a result, seedlings generally exhibited lower water permeability under high temperatures than mature needles. Functionally, deciduous species (cuticles with more aromatic components) exhibited higher g_{min} whereas evergreens (cuticles with more lipidic components) showed lower g_{min}. The results highlight that chemical integration, rather than absolute thickness, is crucial for determining the ability of the cuticle to limit water diffusion. Evergreen species, with their need for persistent, year-round needle durability, developed more robust structural investments, while deciduous species relied more on chemical composition against short-season growing stressors.

Long-term warming experiments further demonstrated the plasticity of conifer seedling cuticles. Heat exposure consistently induced thicker cuticles compared to non-heated, but the chemical pathways underlying this response were species-specific. *Larix decidua* produced an epicuticular wax layer while simultaneously reinforcing the cell wall tissues through lignification, suggesting a multi-layered strategy to enhance mechanical and thermal stability. *Picea abies*, in contrast, reorganized its intracuticular waxes and phenolics into a single transition layer, maintaining an extremely thin cuticle that showed no significant differences in water permeability. If we consider the experimental location, and its high UV exposure, a direct conclusion will be that more aromatic cuticles serve against high level of irradiation. However, recent studies found out that, when implemented within the cutin matrix, flavonoid act as fillers, potentially reinforcing the matrix. This aligns with our results of *P. abies* cuticles and provides an explanation of its effective water retention.

Across all species and contexts, the relationship between cuticle traits and minimum diffusive conductance (g_{min}) emerged as nuanced. Although thin cuticles generally corresponded to higher permeabilities, thickness alone could not explain observed differences. Instead, g_{min} correlated more strongly with the chemical composition and spatial distribution of compounds. Very long-chain aliphatics tended to decrease permeability, while aromatics increased it. The presence or absence of epicuticular waxes did not consistently predict g_{min}, reinforcing the idea that barrier function is governed primarily by the intracuticular domain. These results align with broader findings in cuticle biology. In conclusion, the cuticles of alpine plants exemplify a system in which structure, chemistry, and function converge to mediate plant survival under extreme conditions.

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Cuticle of *Kalmia procumbens* leaves: flavonoids form spines for defense?

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Objective

In this study we focused on the alpine evergreen plant shrub *Kalmia procumbens* growing in high altitudes in the European alps under harsh conditions. Beside a thick cuticle, the plants adapt by impregnation with aromatic components. In this study we aim to get insights into the distribution of flavonoids on the micro-level to come up with a better understanding of adaptation to biotic and abiotic stresses.

Results & Conclusion

Peeling the cuticle resulted in a planar surface of the leaf and allowed revealing microchemistry of the cuticle in 3D: from outside towards the inside epidermal layer. The effect of peeling the cuticle revealed the formation of spines on top and the sides of the peel. Raman imaging revealed that this spines are composed of flavonoids. Temperature experiments increased and accelerated their formation. Also, random cuts on the leaf surface revealed their formation, which point towards a process induced through injuries and probably a defense reaction to seal the outer plant surface.

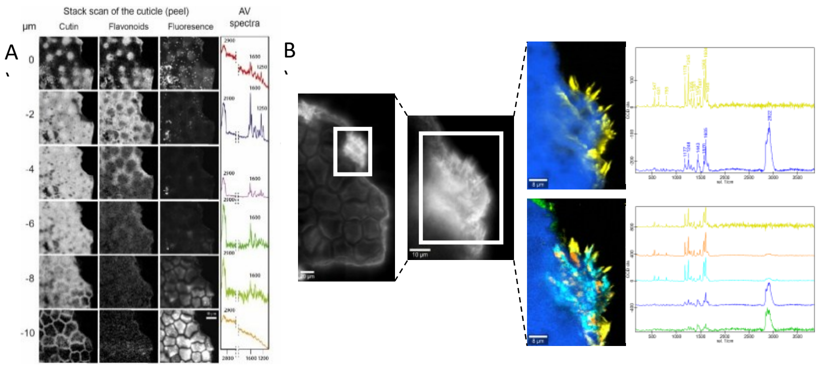

Figure 1. A) Raman stack scan through the cuticle of *Kalmia procumens*, Every 2 µm a Raman area scan was acquired to reveal the chemical changes from top of the surface (0 µm) towards the epidermal layer (-10 µm). By integrating the CH-stretching (2900 cm^{-1}, 1st column) mainly cutin and waxes were visualized. On top (0 µm) the irregular surface structure with knobs appears, followed by a more homogenous distribution until the cellular structure of the epidermal layer appears (-8 to -10µm). On contrast integrating the aromatic bands around 1600 cm^{-1} (2ndcolumn) gives highest intensity at the top and decreases after -4 µm depth. By plotting the background intensity at 1885 cm^{-1}, (3rd column) we noticed a highly fluorescent component as punctae on top and filling the cells in the epidermal layer. The average spectra of each scan (right column), give details on the molecular structure at each depth. B) Spine formation within 24 hours, microscopic picture visualizes spines at the borders of the peel, Raman images based on True Component analysis (TCA) and corresponding component spectrum proofing the molecular changes towards more pure flavonols in the spines.

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Xylem parenchyma cells: determinants for frost resistance in trees?

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Objective

Tree species distribution is often restricted by the environmental constraint Objecfrost. The trees protect themselves by a specific type of cells, xylem parenchyma cells (XPC's) that are essential when it comes to tree lethality. We examine different spieces anatomically to identify their chemical composition to be able to correlate physiological data in understanding the freeze conditioning events within the cells so no lethality occurs.

Results & Conclusion

First raman results with True Component Analysis (TCA) (Figure 1) demonstrate a very active cellular activity in the xylem parenhyma cells of the outermost year ring of the trees, with incorporating lipids, proteins and starch in the different species.

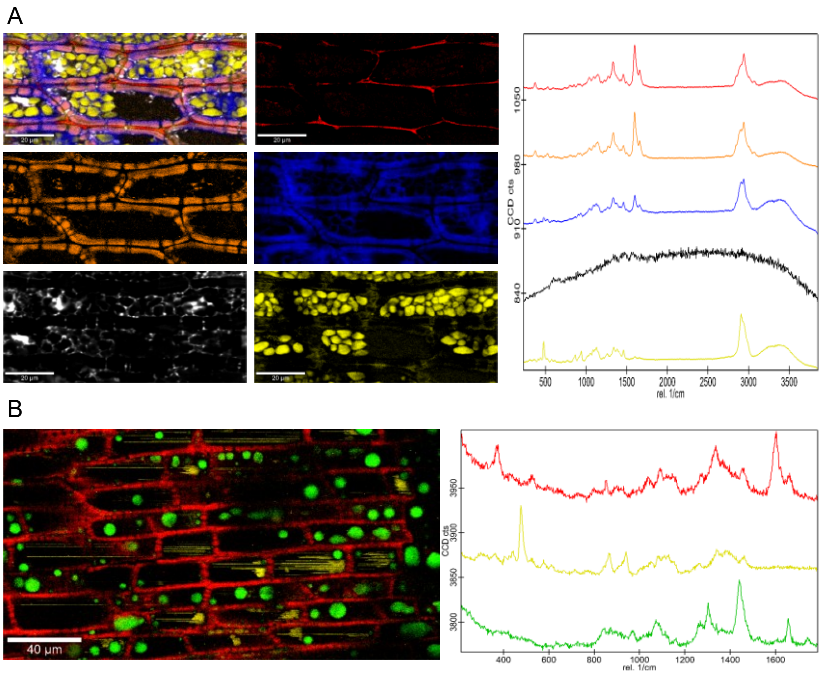

Figure 1. Raman images of the Xylem parenchyma cells (radial microsection) including storage components. A) *Quercus robur* cells filled with starch (yellow) and the corresponding Raman signatures. B) *Tilia cordata* shows additionally to starch also lipids within the parenchyma cells

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Differences in freezing dynamics in the tip and base of wheat (*Triticum aestivum* L.) leaves result in a difference in cold hardiness

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Objective

To determine why wheat leaf tips show greater frost damage ("leaf tip burn") than bases by comparing tip vs. base in cold-acclimated wheat leaves (Fig. 1) in terms of cold hardiness (LT50), freezing dynamics (heat release, percent frozen water, deviation from ideal equilibrium), osmotic potential, ice localization/volume, anatomy, and cell wall microchemistry using confocal Raman microscopy

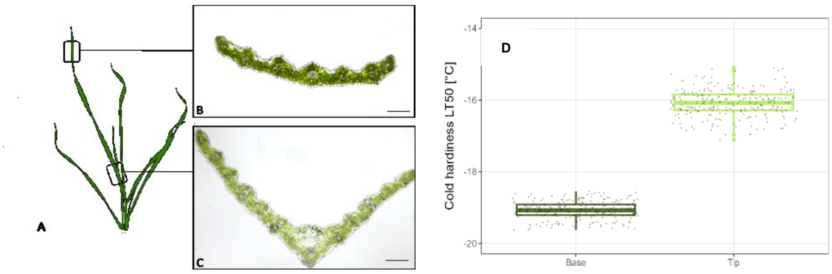

Figure 1. (A) The third leaf of the primary tiller of 8 week old Triticum aestivum plants were used for the experiments. Black rectangles point out the areas of interest, defined to be 1 to 3 cm from the leaf node and 1 to 3 cm from the leaf tip. Light microscopic images of leaf cross sections obtained from (B) the tip and (C) the base area of the third leaf. A prominant midvien is visible in the base but absent in the tip. The black bar corresponds to 200 µm. (D) The difference in cold hardiness (LT50) (from Stegner et al. 2025)

Results

When exposed to similar sub-zero temperatures, the base of the wheat leaf was 3 K more cold hardy than the tip (Fig.1D). Quantitative anatomy (cell wall thickness, cell dimensions) was similar between and did not explain hardiness differences, while Raman microscopy revealed changes in microchemistry. Raman spectra of mesophyll cell walls had relatively stronger carbohydrate bands and spectral features indicating higher esterification of cinnamic acids (e.g., ferulates), suggesting more mature/modified walls at the base than in the tips (Fig.2).

Conclusion

Wheat leaf bases tolerate greater freeze dehydration, freeze more slowly, deviate less from ideal equilibrium, and have mesophyll walls with more esterified cinnamic acids—together conferring about 3 K greater cold hardiness than tips

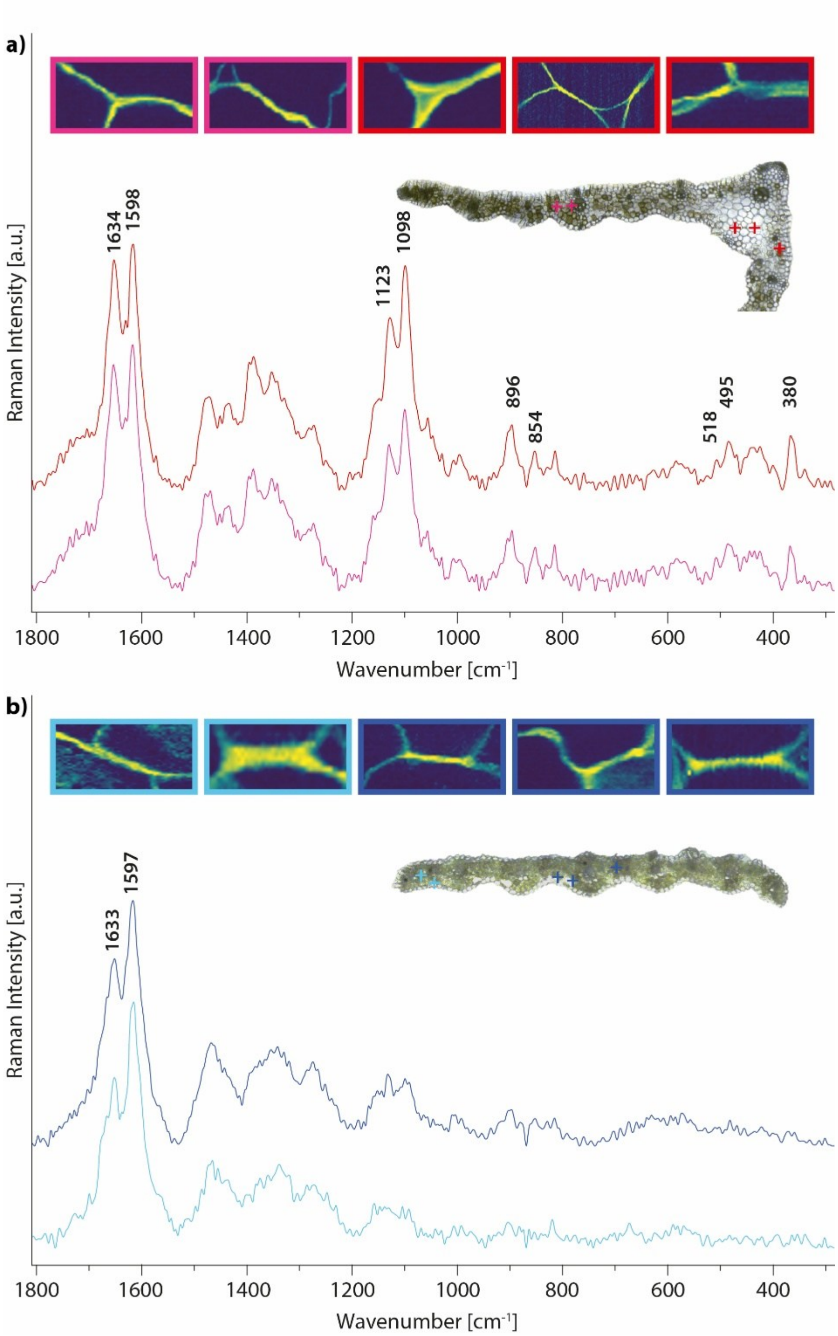

Figure 2. Comparison of parenchyma cell wall composition of Triticum aestivum leaf base and tip based on Raman microscopy: (a) Raman cell wall images show the cell wall structure and a light microscopic overview image below the position of the cell wall scans within the leaf. Average spectra of the middle and edge showed similar bands attributed to aromatic components and carbohydrates. (b) Average spectra from the tip cell walls showed strong aromatic bands and weak carbohydrate bands. (from Stegner et al. 2025)

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Correlative Microscopy for in-depth Analysis of Calcium Oxalate Crystals in Plant Tissues

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Objective

Calcium oxalate (CaOx) crystals are commonly found in many plant species. These crystals vary in distribution and morphology and to elucidate their role in plants multiple methods have been applied. To grasp the full potential of multiple methods in CaOx studies, a novel and easy-to-build correlative sampling approach was developed (Fig.1) and approved on different nut species (pecan (*Carya illinoinensis*), Turkish hazel (*Corylus colurna*) and black walnut (*Juglans nigra*)), including soft tissues (young developmental stages) as well as hard tissues (mature nutshells).

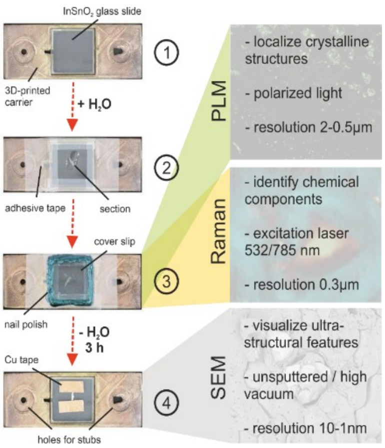

Figure 1. (A) Schematic overview of the sample preparation approach for correlative imaging: The InSnO2 coated microscope slide is placed in the 3D-printed carrier (1) and covered on the edges with adhesive tape (2). The freshly cut section is placed on the slide and sealed with coverslip and nail-polish (3). The sample holder was placed under the light and Raman microscope. For SEM the coverslip was removed, and the sample was air-dried and placed into the SEM fixed with two stubs. (from Niedermeier et al. 2025)

Results

Young seed coat tissues as well as mature nutshells included distinct morphological CaOx features, like druses and prismatic crystals. By Raman imaging the chemical composition of all investigated crystals was verified as calcium oxalate monohydrate (COM) and Raman band intensity changed according to crystal plane orientation with respect to incident laser polarisation. Calcium oxalate dihydrate (COD) was only found in the young *C. illinoinensis* seed coat and was restricted to a few pixels adjacent to cell walls (Fig. 2). These thin cell walls were identified as pectin-rich, while in the mature nutshells the crystals were surrounded by thicker and highly lignified cell walls. The Raman and light microscopy results were correlated with SEM images, which gave additional information on crystal surface structure and/or internal porosity on the nanoscale.

Conclusion

The presented correlative approach preserved the structural integrity of crystals and cellular structures during cutting and transferring between microscopes. Analysing exactly the same sample (position) by Raman, polarized light microscopy and SEM opens the view on the distribution within tissues and cells as well as the molecular structure of the crystals and adjacent cell structures. Such a comprehensive in-situ characterization paves the way for a better understanding of mineralization processes of different minerals in all kinds of biological tissues.

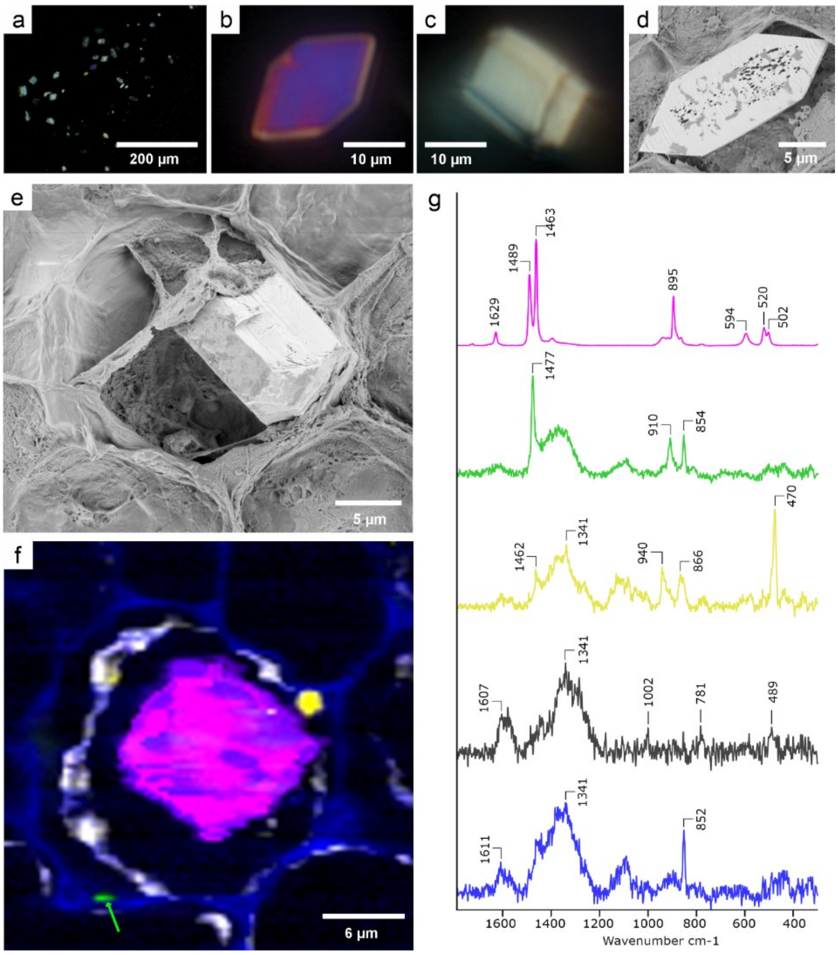

Figure 2. PLM, SEM and Raman of a young pecan shell: a) Image of the shell under polarized light. The gradient of crystal abundance from outside to inside can be seen (from right to left). b and c) Details of single regular crystals in the PLM. The colour in the polarized light depends on its thickness and orientation. d) SEM image of a cut open crystal with porous structure inside. e) SEM image of an intact crystal including dried cell content around. f) Raman map (785nm laser excitation) of the same area revealed 5 different component spectra by TCA (f-g). The crystal was confirmed as COM (1463 cm-1 and 1489 cm-1 band, pink) and additionally COD conformation was detected (green pixels (f)) with a typical COD peak at 1477 cm-1(g, green spectrum). COD was restricted to a few pixels adjacent to the cell wall (f, blue), which is pectin rich due to the band at 852 cm-1(blue spectrum, g). Also close to the cell wall, starch grains were detected (f-g, yellow). The layer between cell wall and crystal (f, white region) showed noisy spectra (strong fluorescence background) and a protein band around 1002 cm-1 as well as some aromatic contribution around 1607 cm-1 (g, black spectrum.). (from Niedermeier et al. 2025)

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Unlock the walnut: How a pectin-rich suture tissue and moisture-driven crack formation induce shell splitting and facilitate seed germination

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Objective

Hard shells and seed coats have evolved to protect seeds, but they often act as barriers to germination. This study delves into the strategies used by walnuts to overcome these protective barriers and enable seed germination. Using chemical imaging, microscopic analysis and 3D reconstructions, we explore the structure and composition of the walnut suture and its disparity to the shell tissue.

Results

Depending on its location on the shell, the suture tissue gradually changes from small, thin-walled to larger, thick-walled and lignified cells (Fig. 1). Raman imaging revealed that the suture is rich in pectin, while lignification starts at the borders to the shell (Fig. 2). To understand the influence of these different tissue compositions on shell splitting, single as well as cyclic rewetting experiments were performed. During drying and rehydration, walnut shells deform remarkably, primarily driven by hygroscopic expansion of the suture due to the high pectin content. The different swelling behavior between the suture and shell triggers the formation of cracks within the splitting zone. Multiple cycles of drying and rehydration subsequently enlarge these cracks, facilitating the opening of the shell during seed germination.

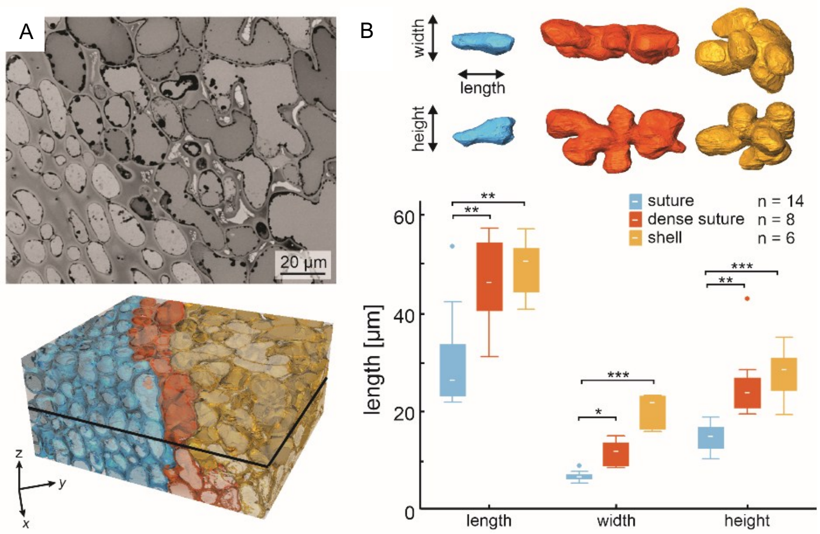

Figure 1. Morphology and cells of the walnut suture tissue. (A) A stack of images of young suture tissue obtained by serial block face SEM (SBF-SEM) and its subsequent 3D reconstruction allowed detailed cell shape analysis. (B) Cell dimensions, oriented with respect to the direction of the suture, vary depending on the tissue type. The thin-walled suture cells are characterised by more cylindrical cells, while the dense suture and shell cells showed more lobation. However, the dense suture cells were lacking lobes perpendicular to the suture. (from Antreich et al. 2025)

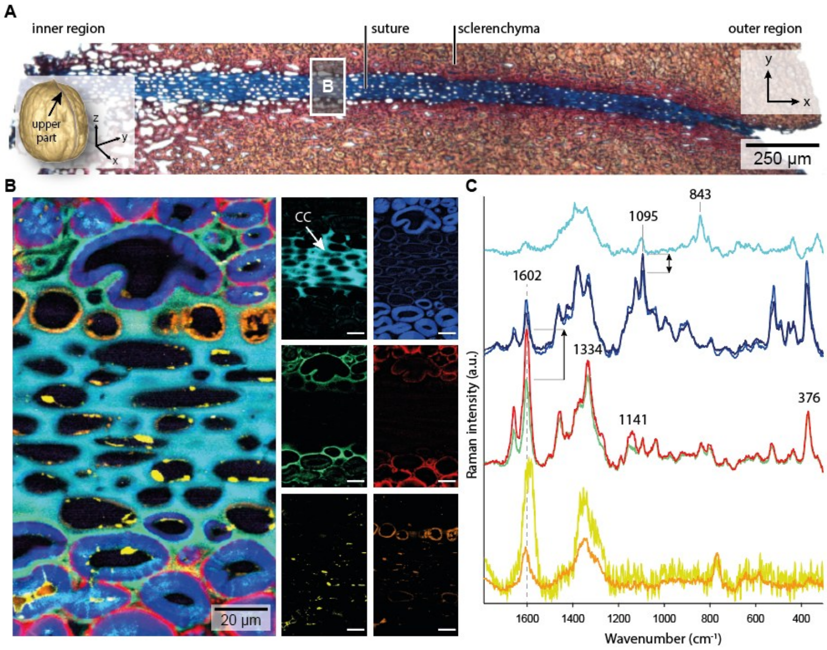

Figure 2. Chemical microanalysis of the upper walnut shell, focusing on the suture region. (A) FCA-stained cross-section of the suture tissue, highlighting chemical differentiation. Non-lignified suture cells (blue) are flanked by lignified sclerenchyma cells (red) in the main shell. The section corresponds to the location indicated in Fig. 1B. (B) Raman chemical maps of the suture and adjacent tissues, generated through True Component Analysis (TCA). Combined component image as well as Individual component distribution images highlight chemically distinct regions. Scale bar: 20 µm. (C) Average Raman spectra of identified components, showing characteristic vibrational bands for pectin in cell corners (CC) and matrix of the suture (cyan), cellulose and hemicellulose in cell walls (CW, blue), and aromatic compounds in intercellular spaces (IC, green, red) as well as aromatic lumen components (yellow, orange). Colour legend corresponds to spatial localization within the Raman map. (from Antreich et al. 2025)

Conclusion

The suture in walnut shells displayed a variety of cell morphologies and differences in cell wall chemistry that favored the formation of cracks predominantly in the upper part of the suture where the radicle will emerge. Consequently, these specialized morphological and mechanical designs have evolved to adapt to a dynamic environment over time as they interact perfectly to maintain the strength of the suture during fall and facilitate its splitting in spring. Understanding moisture-induced suture failure could lead to the design of bioinspired packaging or controlled release systems.

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Study of Microalgae and Their Response to Contaminants

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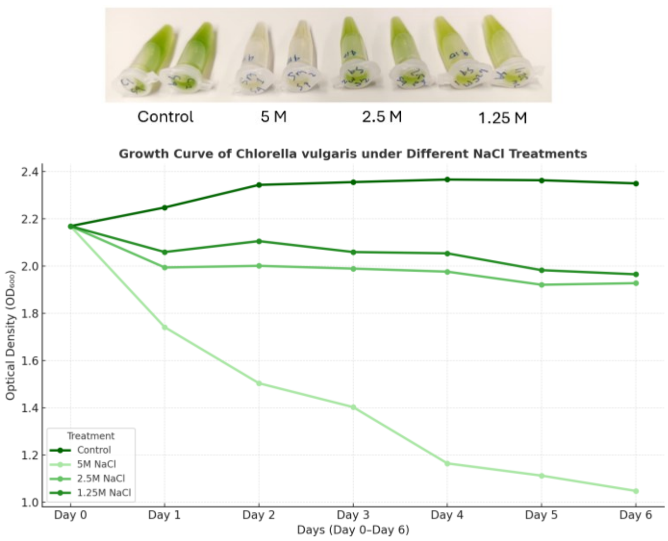
Objective

The objective of this study is to investigate the response of the freshwater microalga *Chlorella vulgaris* to different salinity levels and to assess the impact of osmotic stress on cell growth and viability. The experiment serves as a preliminary step toward advanced biophysical characterization using Atomic Force Microscopy (AFM), aiming to link growth inhibition with changes in cell morphology and mechanical properties under salinity stress.

Results & Conclusion

Optical Density (OD_{681}) measurements (see figure below) over six days revealed a clear salinity-dependent response in *C. vulgaris*. Control cultures exhibited normal growth and stable biomass accumulation. Cultures exposed to 1.25 M and 2.5 M NaCl showed moderate growth inhibition but remained viable, indicating partial osmotic adaptation. In contrast, exposure to 5 M NaCl caused a rapid and sustained decline in OD, reflecting severe osmotic stress and significant biomass loss. Statistical analysis (one-way ANOVA followed by Tukey HSD) confirmed significant differences among treatments ($p < 0.001$). The 1.25 M and 2.5 M treatments were not significantly different from each other, while both differed significantly from the control and the 5 M treatment. These results demonstrate that increasing salinity strongly suppresses *C. vulgaris* growth, with extreme inhibition at 5 M NaCl. In conclusion, *C. vulgaris* shows limited tolerance to elevated salinity, with clear thresholds between moderate and extreme stress conditions. These findings provide a solid experimental basis for subsequent AFM analyses to investigate salinity-induced changes in cell morphology, stiffness, and structural integrity.



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Trends in the discussion of cycling in urban environments: An X-based study

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[3]Institute of Biophysics, Department of Bionanosciences, BOKU VIenna, Austria

Objective

This study aims to analyse the themes and sentiments expressed by bicycle users on X (formerly Twitter) regarding urban cycling since the introduction of the Sustainable Development Goals (SDGs), using text mining techniques to identify public perceptions related to cycling in urban environments.

Results & Conclusions

The analysis of posts from 2016 to 2022 shows a predominance of positive perceptions toward urban cycling, commonly associated with its benefits for health, sustainable mobility, and environmental impact.
However, significant negative sentiments also emerged, primarily linked to insufficient infrastructure, safety concerns, and conflicts with motor vehicles. These mixed perspectives highlight both the recognised value of cycling as an urban transport option and the persistent barriers that limit its widespread adoption. Public discourse on X provides meaningful insight into how urban residents perceive and discuss cycling. The coexistence of positive attitudes and infrastructure-related concerns underscores the need for mobility policies that address user expectations and practical challenges. Integrating these citizen perspectives can support the design of more inclusive and effective urban transport strategies, ultimately contributing to greater public engagement and advancing progress toward the SDGs.

Figure. Main topics found in negative posts. Representative words of the topics found in the LDA model are ordered from left to right and from top to bottom according to their normalised values (z-scores). The word size indicates a higher probability of appearing together with the rest of the words in the topic.

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Publications (SCI articles, reports, preprints, etc.)

Unlock the Walnut: How a Pectin-Rich Suture Tissue and Moisture-Driven Crack Formation Induce Shell Splitting and Facilitate Seed Germination.
S.J. Antreich, N. Xiao, M. Felhofer, N. Gierlinger
Advanced Functional Materials 35 (2025) e10682
doi: 10.1002/adfm.202510682

Correlative microscopy for in-depth analysis of calcium soxalate crystals in plant tissues
M. Niedermeier, S. J. Antreich, N. Gierlinger
Plant Methods. 21 (2025) 136
doi: 10.1186/s13007-025-01463-9

Molecular architecture of developing xylem in Norway spruce reveals spatial and temporal patterns of cell wall polymer deposition
O. Blokhina, Y. Mottiar, N. Gierlinger, C. Jones, W. Willats,
K. Fagerstedt, A. Kärkonen
Journal of Experimental Botany (2025)
doi: 10.1093/jxb/eraf414

Functionalisation of melamine-urea-formaldehyde adhesive wood bondlines with carbon fillers: structures and properties
S. Suarez S, J. Konnerth, N. Gierlinger, M. Riegler, A. Tran
Journal of Adhesion (2025)
doi: 10.1080/00218464.2025.2579190

Chemical, microscopic, and mechanical properties of Mongolian Haloxylon ammodendron wood
D. Gunbilig, N. Gierlinger, P. Charalambous, C. Gusenbauer,
S. Böhmdorfer, A. Potthast A, et al.
Holzforschung 79 (2025) 262
Doi: 10.1515/hf-2024-0118

Differences in freezing dynamics in the tip and base of wheat (Triticum aestivum L.) leaves result in a di_erence in cold hardiness
M. Stegner, M. Ralser, P. Charalambous, G. Tiloca, N. Gierlinger,
G. Neuner, D. P. Livingston III
Plant Stress 16 (2025) 100853
doi: 10.1016/j.stress.2025.100853

Raman micro-spectroscopy uncovers complex structural and chemical adaptations of alpine azalea leaf surface
G. Tiloca, G. Neuner, R. Jetter, N. Gierlinger
Microchemical Journal 213 (2025) 113690
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Phenotypic Cuticle Plasticity at High Elevation: Is Microstructure and Microchemistry Related to Water Permeability?
G. Tiloca, O. Buchner, M. Stegner, N. Gierlinger, G. Neuner
Plant Cell Environment (2025)
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Nanostructured Lipid Carriers for Enhanced Bioaccessibility of Thymoquinone and Its Application in Pure and Sparkling Apple Juice Fortification
A. Ardhi, S. Raharjo, W. A. A. Sudjarwo, M. Schreiner
Food Science and Technology 221 (2025) 117578
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Measuring Colloidal Forces With Atomic Force Microscopy 1: Salt Influence on Hydrophobic and Hydrophilic Interactions
L. N. Ponce-Gonzalez, W. A. A. Sudjarwo, J. L. Toca-Herrera
Microscopy Research and Technique 88 (2025) 1626
doi: 10.1002/jemt.24832

Antimicrobial peptide plectasin recombinantly produced in Escherichia coli disintegrates cell walls of gram-positive bacteria, as proven by transmission electron and atomic force microscopy
M. Müller, S. Myrhofer, W. A. A. Sudjarwo, M. Gibisch, C. Tauer, E. Berger, C. Brocard, J. L. Toca-Herrera, G. Striedner, R. Hahn, M. Cserjan-Puschmann
Journal of Bacteriology 207 (2025) e00456-24
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Surface Rheological Properties and Microstructures of DPPC/POPC Monolayers
W. A. A. Sudjarwo, J. L. Toca-Herrera
Langmuir 41 (2025)16128
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Surface Symphony: Orchestrating DPPC/DOPC Monolayer Behavior
W. A. A. Sudjarwo, J. L. Toca-Herrera
Microscopy Research and Technique (2025)
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Innovative High-Speed Homogenizer Approach for Synthesizing PVDF-GO Membranes from Recycled Battery Graphite
A. Febriasari, F. Ferdiansyah, S. Marwa Salsabila, M. Ridwan, M. B. A. Mahardhika, H. Hilyati, W. A. A. Sudjarwo, N. Arlofa, S. Supriyadi, J. L. Toca-Herrera, S. Kartohardjono
Indonesian Journal of Chemistry (2025), 25 (5): 1371-1383
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Single-molecule FRET and tracking of transfected biomolecules in living cells
Anandamurugan, A. Eidloth, V. Frank, P. Wortmann, L Schrangl, C. Lan, G. J. Schütz, T. Hugel
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Synthesis, Microbiology, and Biophysical Characterization of Mutanofactins from the Human Oral Microbiome
L. Lüthy, L. G. S Thies, K. N. Beitl, M. Hansen, J. McManus, M. Afzal, L. Schrangl, S. Bloch, G. Subbiahdoss, E. Reimhult, C. Schäffer, E. M. Carreira
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doi: 10.1021/acscentsci.4c02184

BPS2025-Synaptic force shielding in T cell receptor-ligand interactions
L Schrangl, F Kellner, R Platzer, JL Toca-Herrera, JB Huppa, GJ Schuetz, et al.
Biophysical Journal 124 (2025), 530a

CD4+T-cells create a stable mechanical environment for force-sensitive TCR:pMHC interactions
L. Schrangl, F. Kellner, R. Platzer, V. Mühlgrabner, P. Hubinger, J. Wieland, R. Obst, J. L. Toca-Herrera, J. B. Huppa, G. J. Schütz, J. Göhring
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Measuring Molecular Forces With Atomic Force Microscopy 1: Solvent Influence on Hydrophobic Interactions.
L. N. Ponce-Gonzalez, J. L. Toca-Herrera
Microscopy Research and Technique (2025)
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Oligomer assembly of Bacillus thuringiensis Cyt2Aa2 on lipid membranes reveals a thread-like structure
C. Tangsongcharoen, J.L. Toca-Herrera, B. Promdonkoy, K. Srisucharitpanit, S. Tharad
Toxicon X 26 (2025) 100220
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Trends in the Discussion of Cycling in Urban Environments: An X-Based Study
L. Antón-González, M. Pellicer-Chenoll, I. Villarrasa-Sapiña, J. L. Toca-Herrera, L.-M. González, J. Devís-Devís
Plos ONE 20 (2025) e0330616
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Exploring the Effect of Roasting and Ultrasound Treatment on the Emulsifying Properties and Oxidative Stability of Flaxseed Gum-Stabilized Oil-in-Water Emulsions
E. M. Raoui, M. Hadidi, J. L Toca-Herrera, A. Einschütz Lopez, G. Subbiahdoss, H. Peterlik, M, Pignitter
Future Foods 12 (2025) 100777
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Arbore SARS-CoV-2 Detection by ddPCR in Adequately Ventilated Hospital Corridors
J. Truyols-Vives, M. González-López, A. Colom-Fernández, A. Einschütz-López, E. Sala-Llinàs, A. Doménech-Sánchez, H. García-Baldoví, J. Mercader-Barceló
Toxics, 13 (2025) 13070583
doi : 10.3390/toxics13070583

Conferences, seminars, schools, and workshops

<u>Participation</u>

Title: From Chemistry to Clean Air: Smart Materials in Action (talk)
Author: W. A. A. Sudjarwo
General Lecture: Setia Budi University
Surakarta, Indonesia (14.11.2025)

Title: Affinity-Based Recognition (talk)
Author: W. A. A. Sudjarwo
General Lecture: Brawijaya University
Malang – East Java, Indonesia (24.04.2025)

Title: Method Validation of Sensor Assay (talk)
Author: W. A. A. Sudjarwo
General Lecture: Brawijaya University
Malang – East Java, Indonesia (26.04.2025)

Title: Phenotypic and Chemical Cuticle Plasticity in Kalmia procumbens (best talk award)
Authors: G. Tiloca, G. Neuner, B. Othmar, S. Matthias, J. Reinhard, G. Notburga
Conference: Austrian Society of Plant Biology (ATSPB)
Tulln, Austria (29-31.05.2025)

Title: Cuticle of Kalmia procumbens leaves: flavonoids form spines for defense? (2nd Poster prize award)
Authors: C. Paraskevi, G. Neuner, B. Othmar, N. Gierlinger
Conference: Austrian Society of Plant Biology (ATSPB)
Tulln, Austria (29-31.05.2025)

Title: Raman Imaging of Plant Cuticles (talk)
Author: N. Gierlinger
Seminar: LMU Munich
Munich, Germany, (08.01. 2025)

Title: Plant Raman Hyperspectral Imaging (talk)
Author: N. Gierlinger
Seminar: "FillingGaps Scientific Seminar: Plant Imaging"
Nantes, France (25-26.06.2025)

Title: Raman Imaging of Plant Cells (talk)
Author: N. Gierlinger
Seminar: "TU Science Days 2025"
Vienna, Austria (17-18.06.2025)

Title: Kann die Technik von Tricks aus dem Pflanzenreich lernen? (talk)
Author: Gierlinger Notburga
Lecture: Kinderuni 2025
Vienna, Austria (10.07.2025)

Title: Wie können Nüsse zur nachhaltigen Lösung im Plastikzeitalter werden? (talk)
Author: Gierlinger Notburga
Seminar: HTL-Congress "FutureConvent 2025"
Gmunden, Austria (12.11.2025)

Title: Synaptic force shielding in T-cell receptor–ligand interactions (poster)
Authors: L. Schrangl, F. Kellner, R. Platzer, J. L. Toca-Herrera, J. B. Huppa, G. J. Schütz, J. Göhring
Conference: 69th Annual Meeting of the Biophysical Society
Los Angeles, USA (15-19.02.2025)

Title: Single-molecule FRET measurements of TCR-exerted mechanical forces and bond lifetime estimation within the immunological synapse (poster)
Authors: L. Schrangl, F. Kellner, R. Platzer, J. L. Toca-Herrera, J. B. Huppa, G. J. Schütz, J. Göhring
Conference: Biomembrane Days 2025
Berlin, Germany (29.09-01.10.2025)

Title: Forces Between Hydrophobic Surfaces: Solvent Influence
Authors: Luis N. Ponce-Gonzalez, Jose L. Toca-Herrera
Conference: 7th Conference of Young Researchers in Colloids and Interfaces (JICI-7)
Valencia, Spain (28-30.05.2025)

Title: Measuring colloidal and molecular forces with AFM: salt and solvent influence on hydrophobic interactions (poster)
Authors: L. N. Ponce-Gonzalez, J. L. Toca-Herrera
Conference: Joint Annual Meeting of the Austrian Physical Society and Swiss Society (ÖPG-SPS)
Vienna, Austria (8-22.08.2025)

Title: Atomic Force Microscopy (AFM) Analysis of Cellular Mechanics Following Measles Vaccine Virus Infection (poster)
Authors: A. Einschütz Lopez, J. Bacher, J.L. Toca-Herrera
Conference: Joint Annual Meeting of the Austrian Physical Society & Swiss Physical Society (ÖPG-SPS)
Vienna, Austria (8-22.08.2025)

Title: Understanding Biological Material Mechanics Through Energy Dissipation (poster)
Author(s): A. Weber, J.L. Toca-Herrera
Conference: Joint Annual Meeting of the Austrian Physical Society & Swiss Physical Society
Vienna, Austria (8-22.08.2025)

Title: Measuring colloidal and molecular forces with AFM: salt and solvent influence on hydrophobic interactions
(1st poster award)
Authors: L. N. Ponce-Gonzalez, J. L. Toca-Herrera
Conference: International School of Medical Bionanotechnology and Medicine (CNR-Nanotec)
Lecce, Italy (30-31.10.2025)

Title: Measles Virus induced cytoskeletal alteration and their biomechanical consequences
Authors: A. Einschütz López, J. Bacher, J. L. Toca-Herrera
Conference: International School of Medical Bionanotechnology and Medicine (CNR-Nanotec)
Lecce, Italy (30-31.10.2025)

Title: Measuring colloidal and molecular forces with AFM: media influence on hydrophobic interactions (talk)
Authors: L. N. Ponce-Gonzalez, J. L. Toca-Herrera
Conference: 2025 Vienna Soft Matter Day
Vienna, Austria (21.11.2025)

Title: Atomic force microscopy: what can we do with it
Author: J. L. Toca-Herrera
Seminar: Online webinar for EU Project CARES
Vienna, Austria (2025)

Title: Bacterial fusion proteins as fluorescent sensors (poster)
Authors: B. Kainz, J. L. Toca-Herrera
Conference: Weber symposium on Innovative Fluorescence Methodologies in Biochemistry and Medicine
Genoa, Italy (15-20.06.2025)

Title: Cell Mechanical Alterations Induced by Infection with a Measles Vaccine Virus measured by Atomic Force Microscopy (poster)
Authors: A. Einschütz Lopez, J. Bacher, J.L. Toca-Herrera
Conference: 15th European Biophysics Congress (EBSA 2025)
Rome, Italy (30.06-04.07.2025)

Organization

J. L. Toca-Herrera. Co-organizer of the 2nd ACERA (Association of Spanish Scientist in Austria) meeting, held at BOKU Vienna (Austria) in 2025, May 23rd

J. L. Toca-Herrera. Co-organizer of the 3rd edition International School of Medical Bionanotechnology and Nanomedicine (InterNanoBioMed), held at CNR Nanotec in Lecce (Italy) in 2025, October 30th – 31st

Ongoing projects, national and international collaborations

General information about projects and research topics:
https://forschung.boku.ac.at/de/department/iBIPH

Projects

Puzzle Zellen aus Nussschalen: ein Abfallprodukt mit Potential für nachhaltige Materialien?
Funded by the European Commission (EU).
Project duration: 01.09.2023 - 28.02.2025. PI: Notburga Gierlinger.

Adaptations for fog and dew harvesting in cactus spines.
Funded by the Austrian Science Fund (FWF) (DOI).
Project duration: 01.08.2022 - 31.07.2025. PI: Jessica Huss.

Transpiration in heat.
Funded by the Austrian Science Fund (FWF).
Project duration: 01.11.2021 - 31.10.2025. PI: Notburga Gierlinger.

Ice lacunae in plant tissues.
Funded by the Austrian Science Fund (FWF).
Project duration: 01.08.2021 - 31.07.2025. PI: Notburga Gierlinger.

Assessment of Anthropogenic Impacts as an Approach to Fish Biodiversity Conservaton; the Case of River Awash, Ethiopia.
Funded by the Austrian Agency for Education and Internationalisation (OeAD).
Project duration: 01.10.2023 - 30.09.2026. Grant holder: Mahder Mekonnen Shumi. Supervisor: Jose L. Toca-Herrera.

Hierarchical polymer niches for improved cell adhesion.
Funded by the Austrian Science Fund (FWF).
Project duration: 01.11.2022 - 31.10.2026. PI: Jose L. Toca-Herrera.

In-depth Study of Four Divisions of Microalgae and Their Response against Contaminants.
Funded by the Austrian Agency for Education and Internationalisation (OeAD).
Project duration: 16.03.2024 - 15.03.2027.
Grant holder: Yudho Harjoyudanto. Supervisor: Jose L. Toca-Herrera.

Human ECM-based platform for anti-cancer drug testing – CARES.
Funded by the European Commission (EU).
Project duration: 01.11.2023 - 31.10.2027. PI: Jose L. Toca-Herrera.

Limiting low temperatures for the tree xylem.
Funded by the Austrian Science Fund (FWF).
Project duration: 01.12.2024 - 30.11.2027. PI: Notburga Gierlinger.

Main collaborations

- Assoc. Prof. Rafael **Benítez**, University of Valencia, Spain
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- Prof. Ingo **Burgert**, ETH Zurich, Switzerland
- Dr. Sarah **Cookson**, INRAE France
- Prof. Anna **de Juan**, University of Barcelona, Spain
- Prof. John **Dunlop**, Universität Salzburg
- Prof. Michaela **Eder**, LMU Munich
- Prof. Kurt **Fagerstedt**, Universität Helsinki
- Prof. Wolfgang **Gindl**, Universität für Bodenkultur Wien, Austria
- Dr. Janett **Göhring**, Universität für Bodenkultur Wien, Austria
- A.o. Prof. Andreas **Holzinger**, Universität Innsbruck
- Prof. Till **Ischebeck**, Universität Münster
- Prof. Magnus **Johnson**, KTH Stockholm
- Dr. Chartchai **Krittanai**, Mahidol University, Thailand
- A.o. Prof. Ingeborg **Lang**, Universität Wien
- Prof. Anna **Lippert**, University of Würzburg, Germany.
- A.o. Univ. Prof. Ursula **Lütz-Meindl**, University of Salzburg, Austria
- Prof. Shawn D. **Mansfield**, University of British Columbia, Canada
- Dr. Thibaud **Messerschmid**, LMU Munich
- Prof. Luis **Millán González**, University of Valencia, Spain
- Dr. Christiane **Nawrath**, Université de Lasuanne
- A.o. Prof. Gilbert **Neuner**, Universität Innsbruck
- Prof. Georg **Papastavrou**, University of Bayreuth, Germany
- Prof. Marc **Pignitter**, Wien Universität, Austria
- Prof. Gerald **Striedner**, Universität für Bodenkultur Wien, Austria
- Dr. Maria **Vivanco**, CICbioGUNE, Spain
- Prof. Cordt **Zollfrank**, LMU Munich