Tuning the Interactions between Biomolecules and Surfaces via a Peptide Monolayer Framework

Check out our website!

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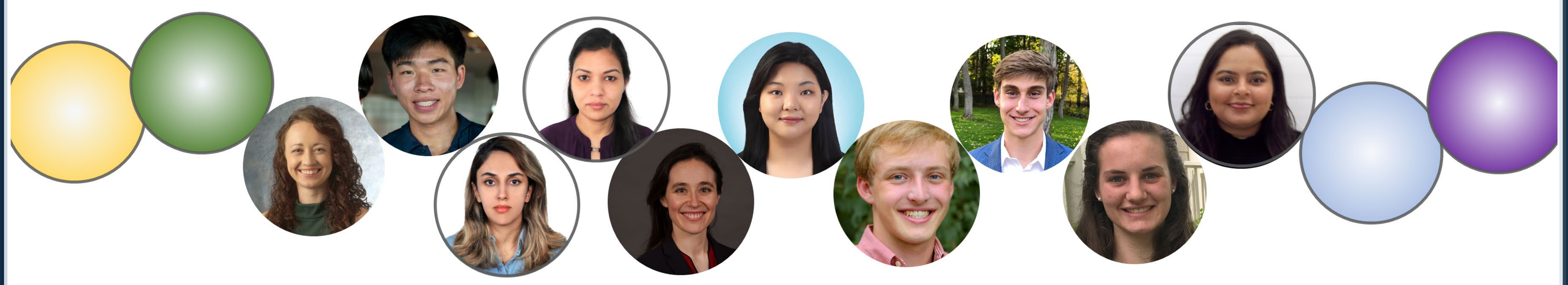
The Renner Laboratory



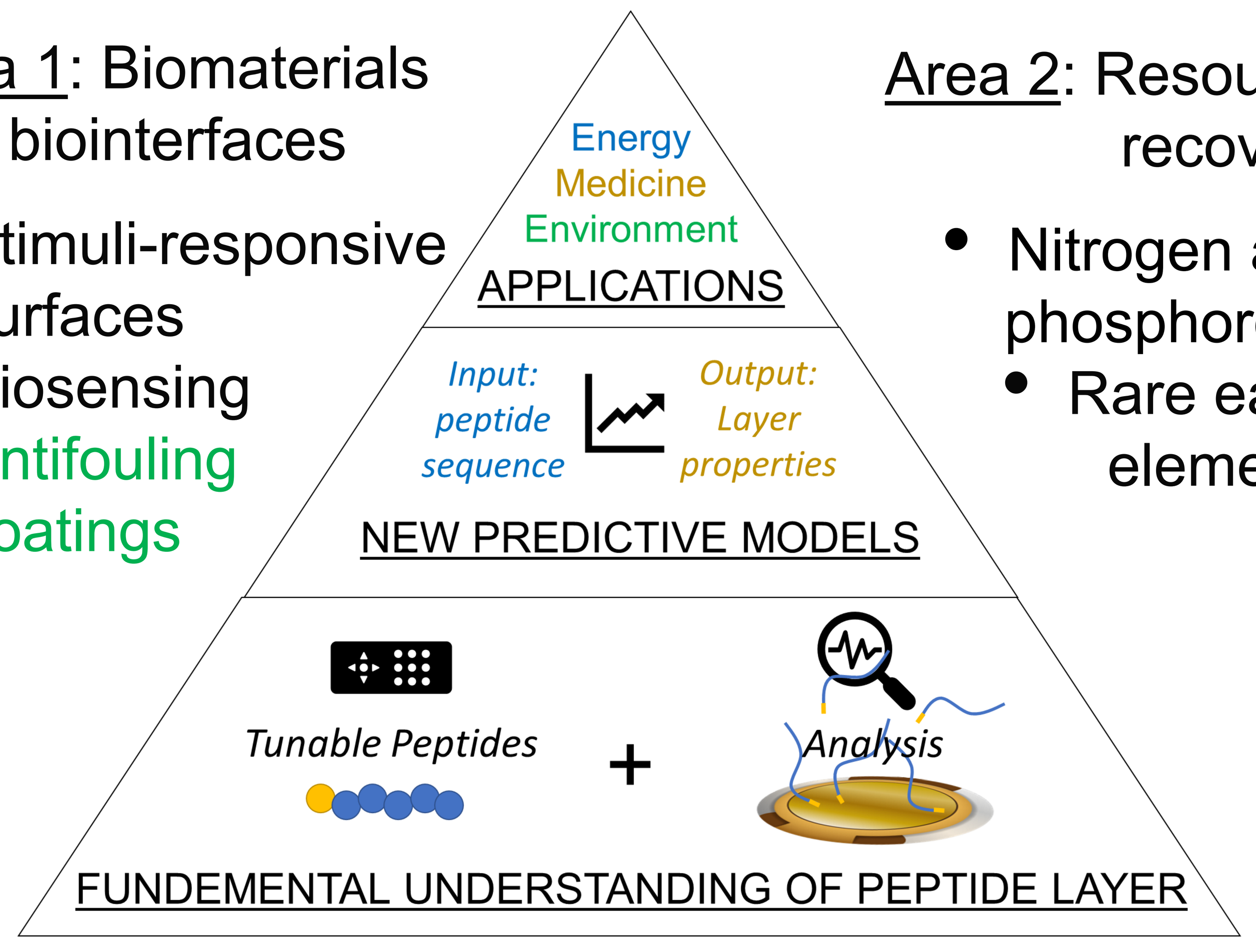
We engineer interfaces with polypeptides!

Area 1: Biomaterials and biointerfaces

- Stimuli-responsive surfaces
- Biosensing
- Antifouling coatings

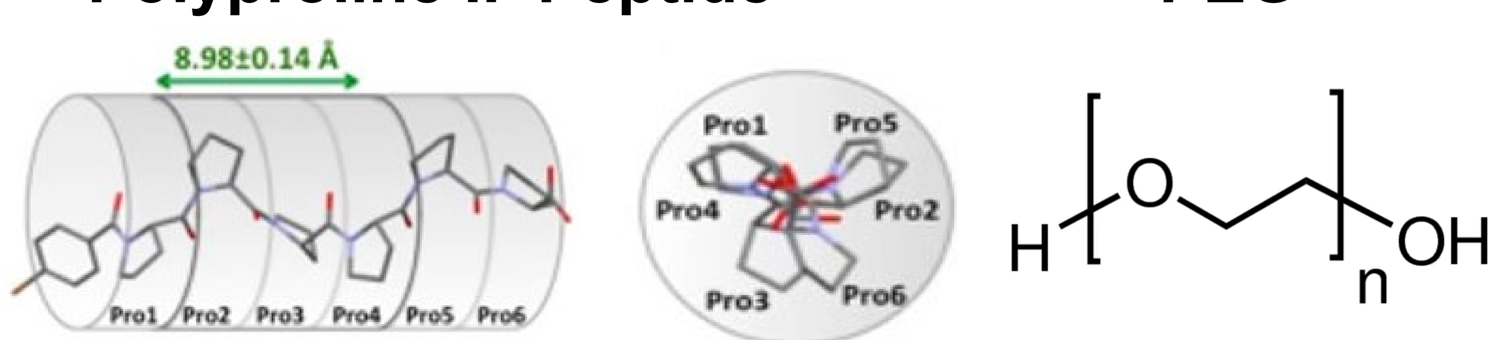
Area 2: Resource recovery

- Nitrogen and phosphorous
- Rare earth elements



Polyproline II (PPII)

Polyproline II Peptide[1] PEG



Research Need:

- Implantable medical devices are needed to reduce patient burden for chronic diseases
- Fouling of devices is a major barrier to implementation
- PEG prevents fouling but also can bioaccumulate and illicit an immune response

Solution:

- Polyproline has special properties allowing high packing and is a promising material for antifouling
- Peptide-based structures are easily tunable, multi-functional biocompatible, and controllable

Peptide Design and Goal

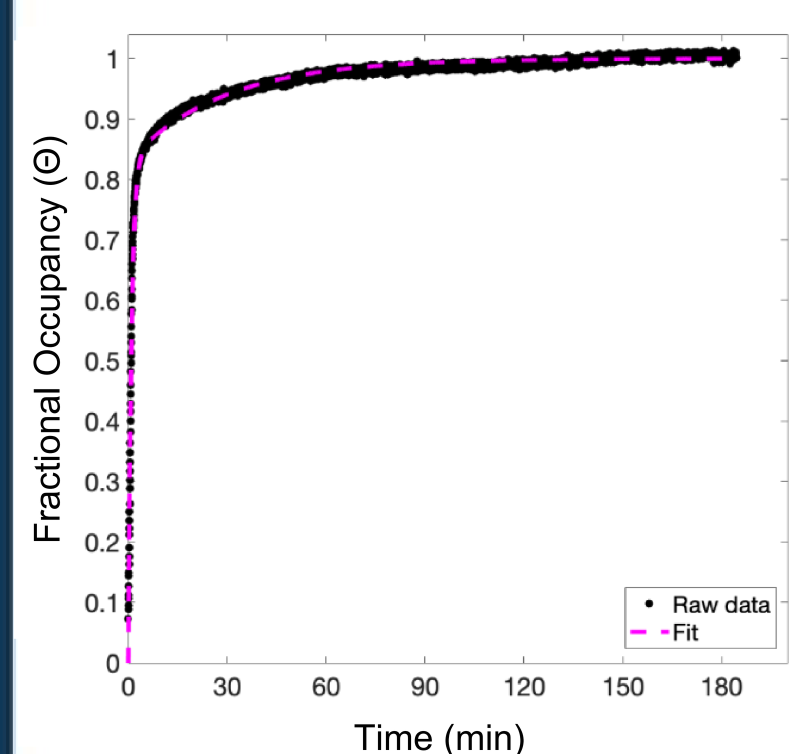
(GPPXPPG)$_2$C X = Guest Residue[2]

X can be chosen for varying PPII propensity, hydrophobicity, chemistry and bulkiness

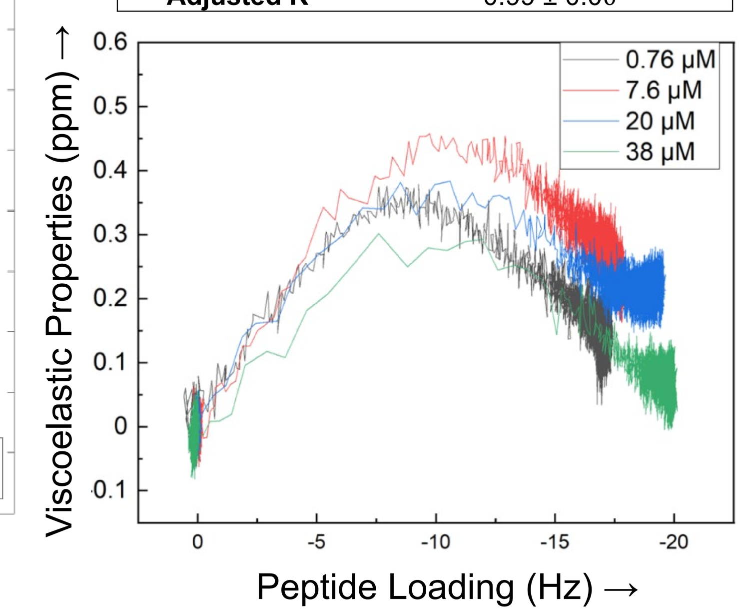
Goal: Understand PPII peptide assembly and antifouling properties to generate a predictable framework

Results

Adsorption Behavior

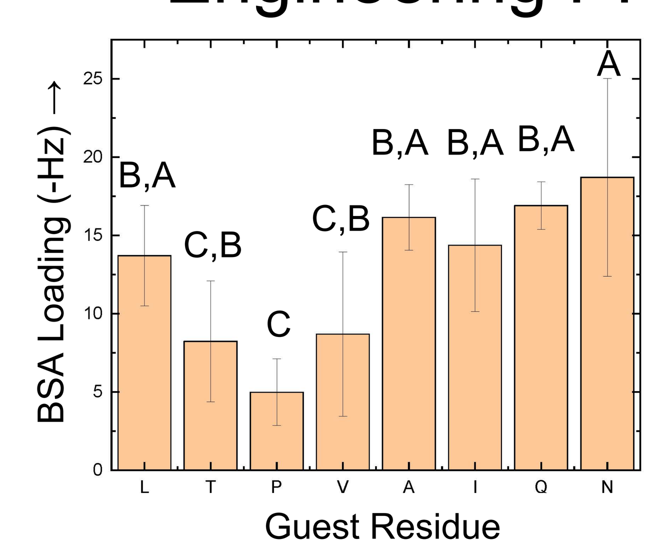


Parameter	Average ± standard error
k_a (L mol^{-1} s^{-1})	2600 ± 800
k_d (s^{-1})	0.0036 ± 0.0010
k_t (s^{-1})	0.00064 ± 0.00014
Adjusted R^2	0.99 ± 0.00

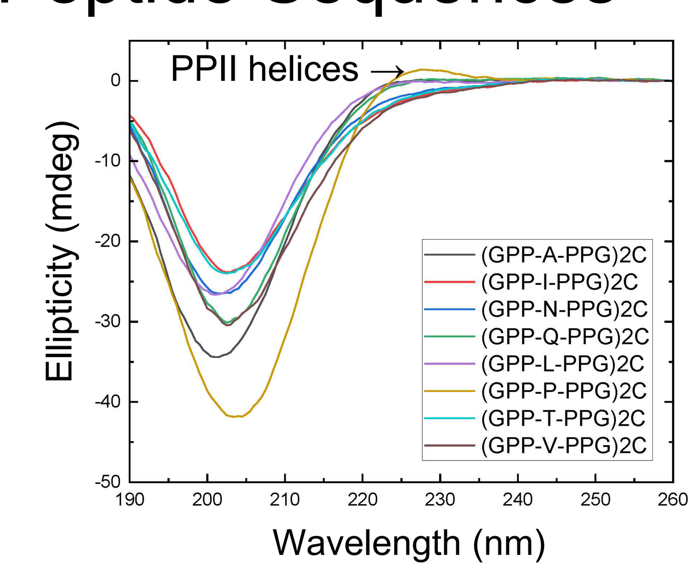


- Quartz crystal microbalance with dissipation (QCM-D) monitoring allows analysis of adsorption and fouling
- The fractional occupancy (Θ) of PPII peptide adsorption with time can be described via the Langmuir adsorption and rearrangement model[3]

Engineering PPII Peptide Sequences



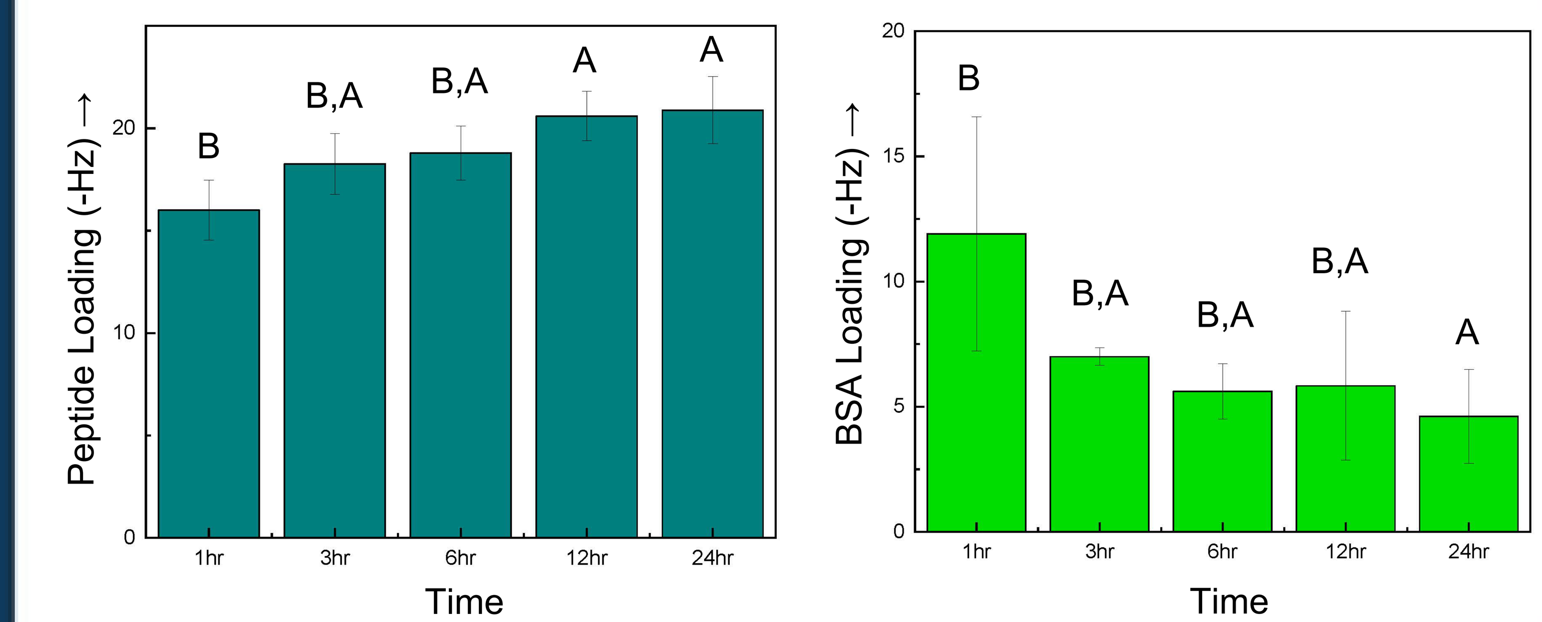
*A,B,C represent statistically similar groupings via Tukey's post hoc test after significant ANOVA test



- Sequences with P as the guest residue have the highest antifouling properties, despite having statistically similar loading as all other sequences tested
- Peptide sequences that include P as the guest residue have higher PPII helix content

Results (cont.)

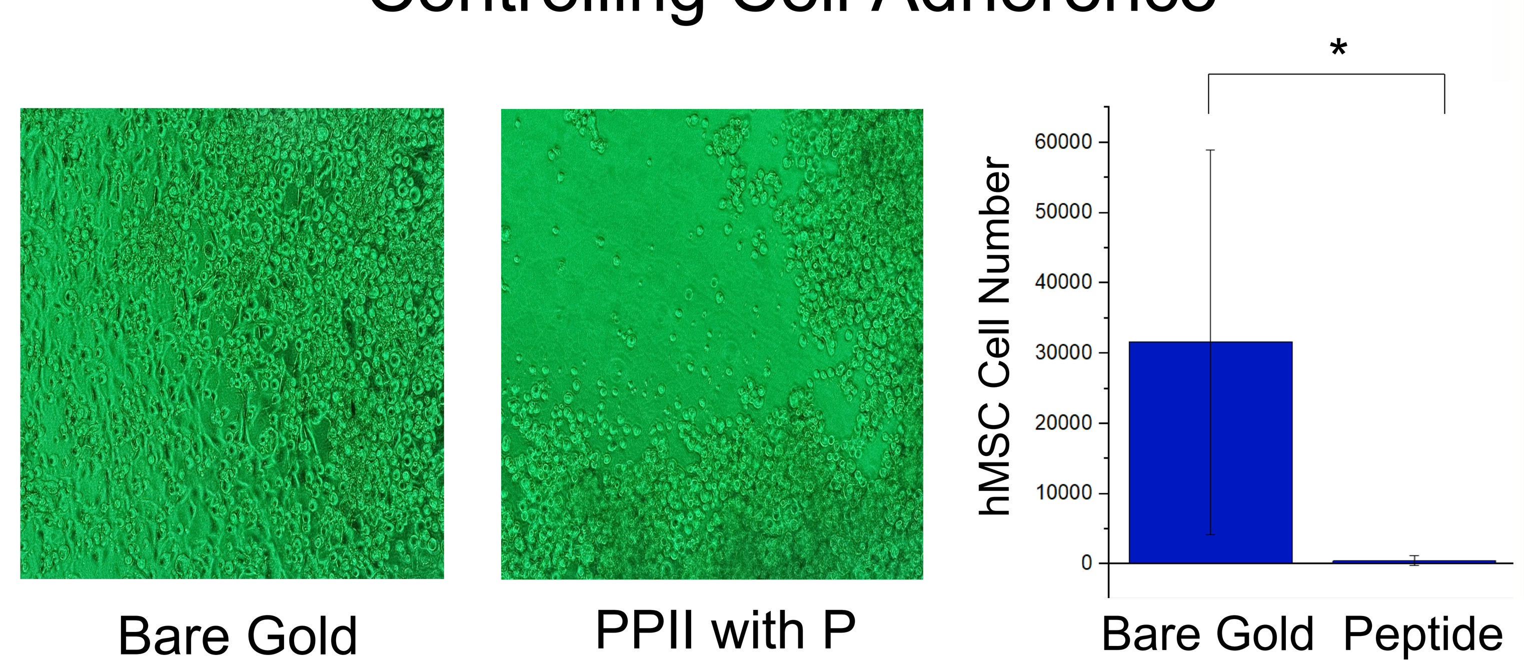
Controlling Fouling via Peptide Loading



*A,B,C represent statistically similar groupings within one bar chart via Tukey's post hoc test after significant ANOVA test, loading and fouling were found to be significantly linearly correlated via linear regression

- Kinetically controlled loading significantly impacts the amount of fouling in PPII peptides with P as the guest residue – other factors such as % rearrangment, PPII propensity and proline content are also being explored

Controlling Cell Adherence



* are statistically different via t-test

- Antifouling studies of human mesenchymal stem cells (hMSCs) has tissue engineering implications
- PPII-coated gold surface prevents hMSC adherence

References

[1] Wilhelm et al. J. Am. Chem. Soc., 2014, 136, 45, 15829–15832
[2] Brown et al. J. Biochem., 2012, 51 (25), 5041-5051
[3] Hostert and Renner et al. Langmuir, 2021, 37 (20), 6115-6122

Acknowledgements

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