

Comprendre les mécanismes de floculation naturelle chez les microalgues pour améliorer l'efficacité de récolte par flottation

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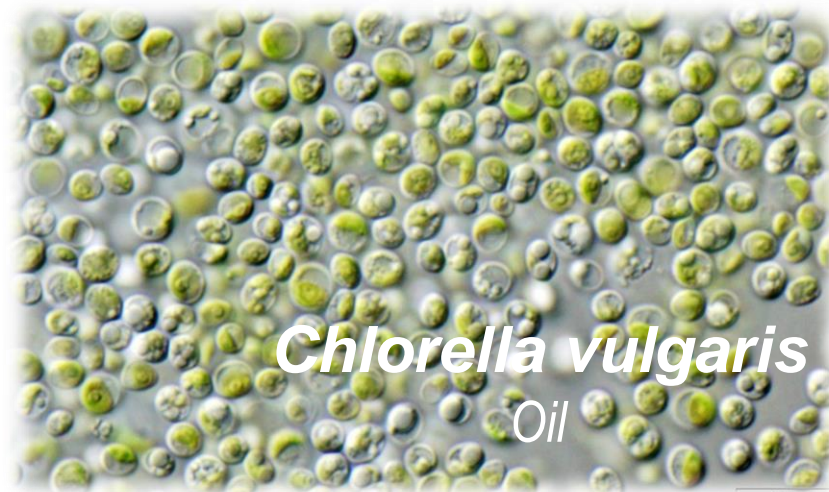
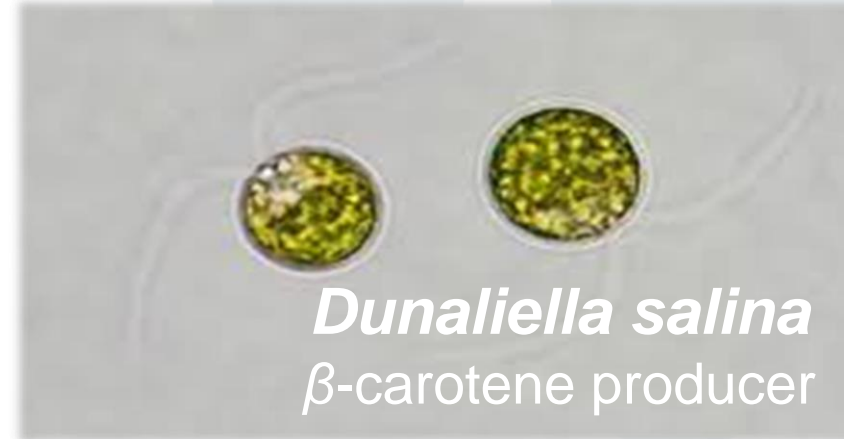
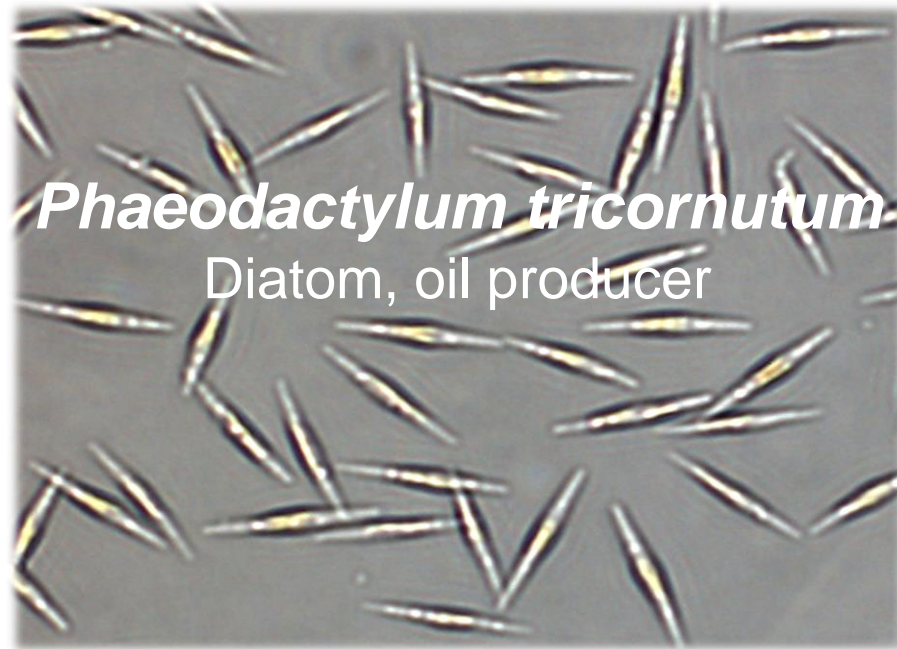


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Microalgae = microorganisms with great potential



Large-scale harvesting of microalgae is a challenge



“Classic” harvesting technique

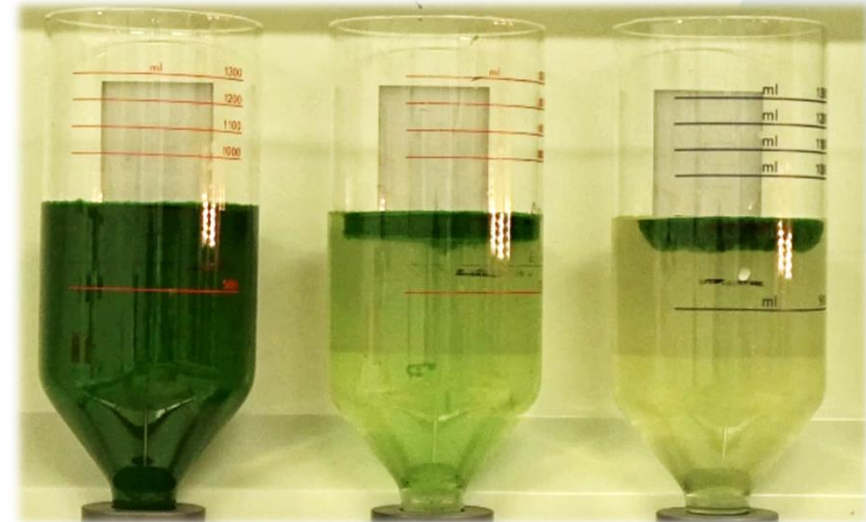
- Centrifugation
- Filtration
- Sedimentation

**Important costs (1/3 of total price)
+ cells damaged!**

Flotation

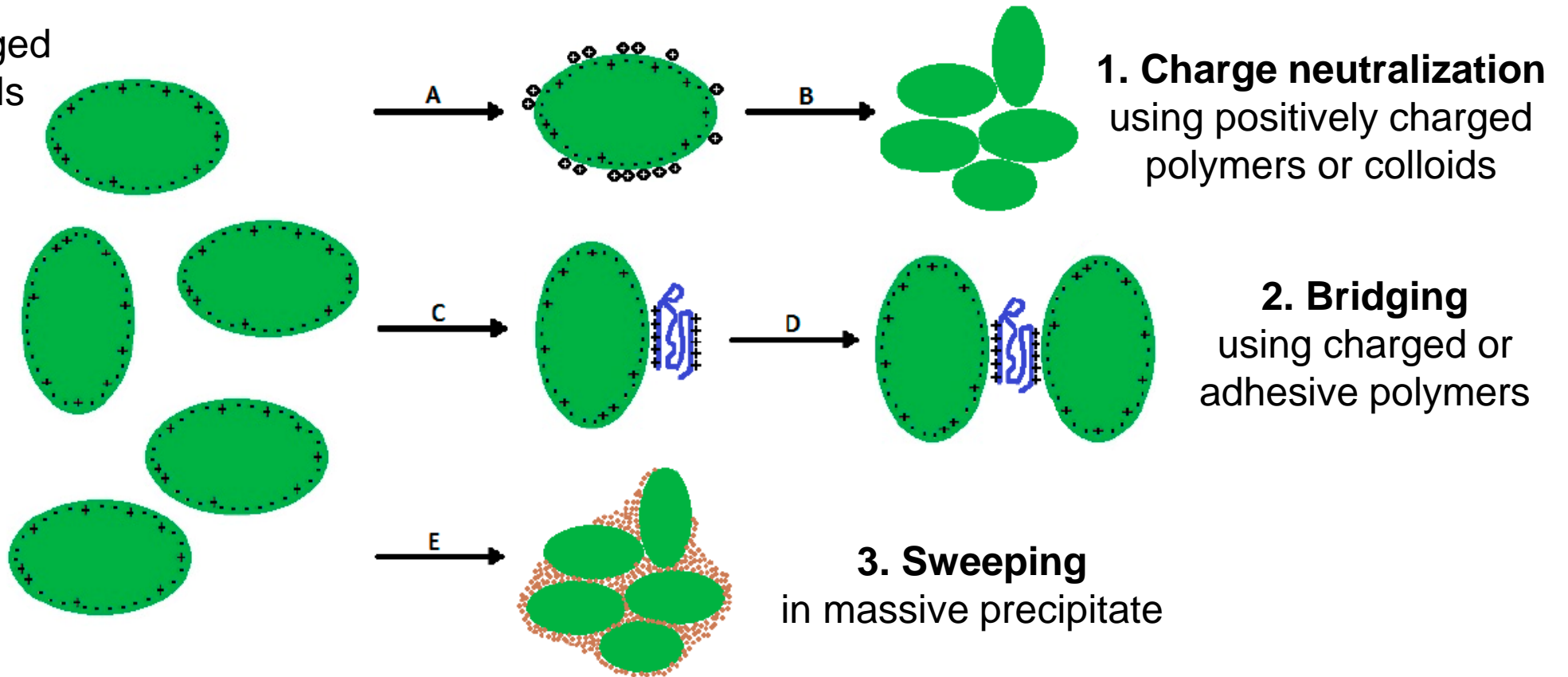
- Cell capture by rising bubbles
 - Reduced harvesting costs
 - Non-damaging
- Requires prior flocculation (repulsive interactions)

**Use of chemical flocculants to form flocs easier
to separate from the water**



Flocculation mechanisms in microalgae

Microalgae
negatively charged
hydrophilic cells

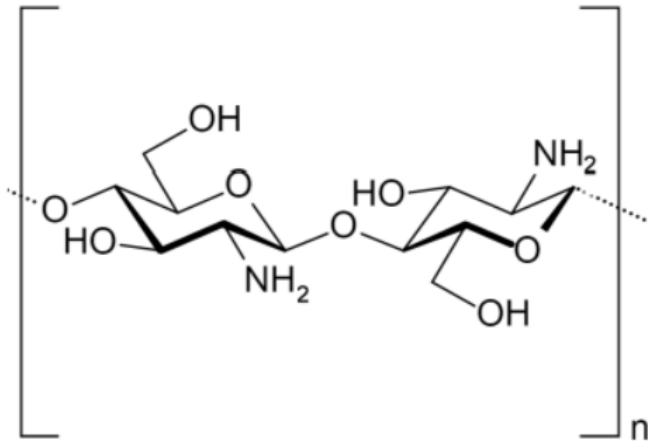


Develop multi-scale approaches to understand these mechanisms for different microalgae species and different flocculants

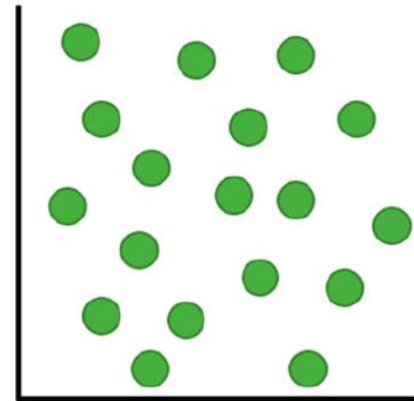
Chitosan is a bio-sourced flocculant widely used

Chitosan

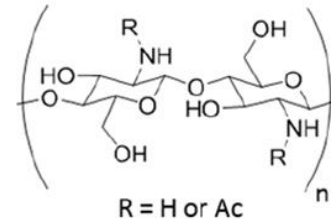
- Positively charged at $\text{pH} < \text{pKa}$ (6)
- Flocculates the cells through charge neutralization



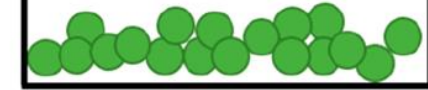
N. oculata



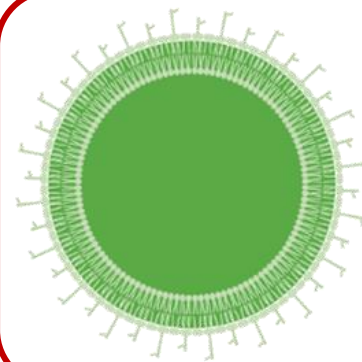
Chitosan ($\text{pH} > 7.5$)



Sweep flocculation



Blockx et al. ACS Sustain Chem Eng, 2018



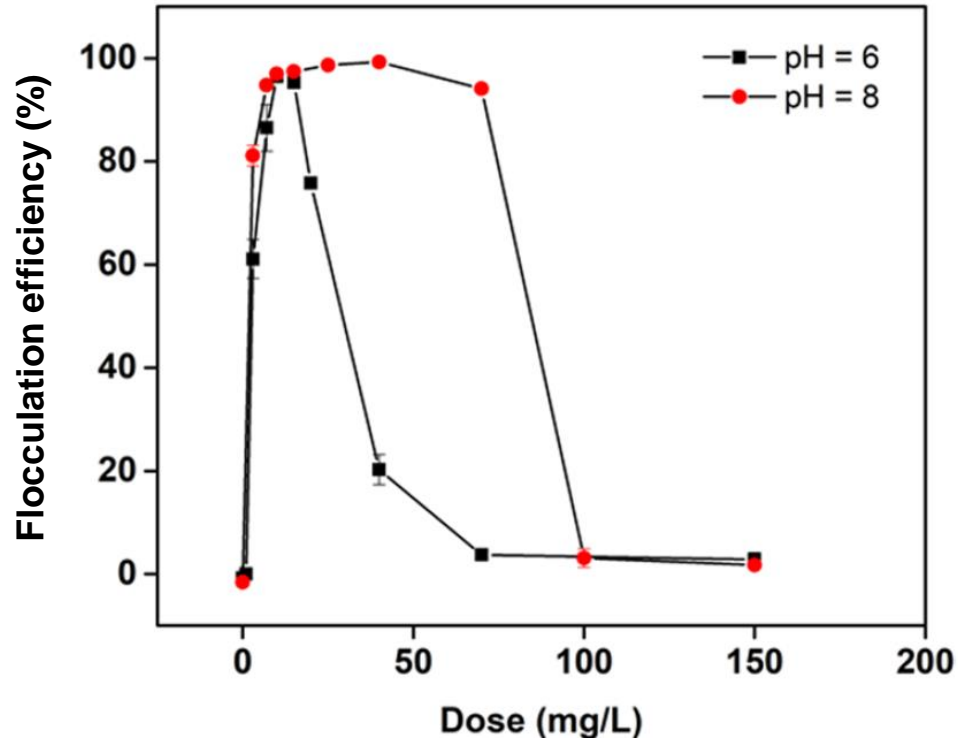
Higher polysaccharide content in the cell wall results in better flocculation

Cheng et al., Process Biochem, 2018

This suggests that the flocculation mechanism may not be fully understood and may rely not only on electrostatic interactions!

Flocculation experiments confirm our hypothesis

Flocculation experiment



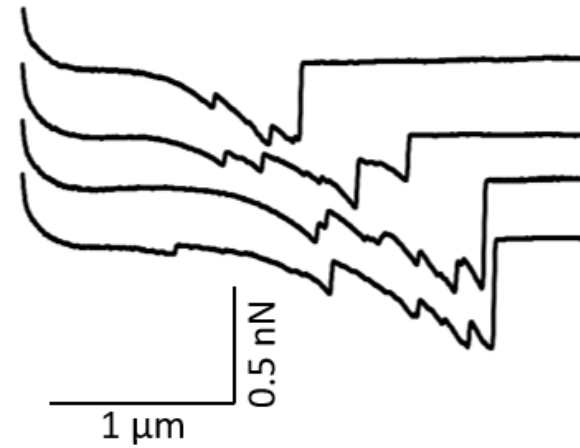
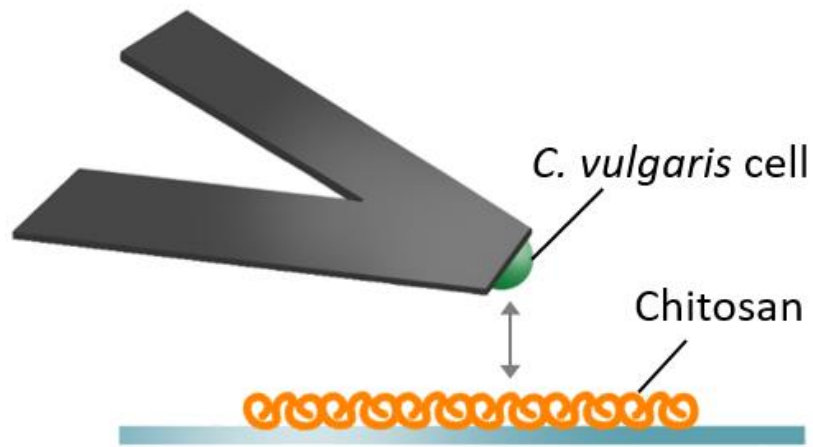
Macroscopic observations



- Chitosan flocculates cells both at pH 6 and 8
 - Cells do not aggregate at pH 8

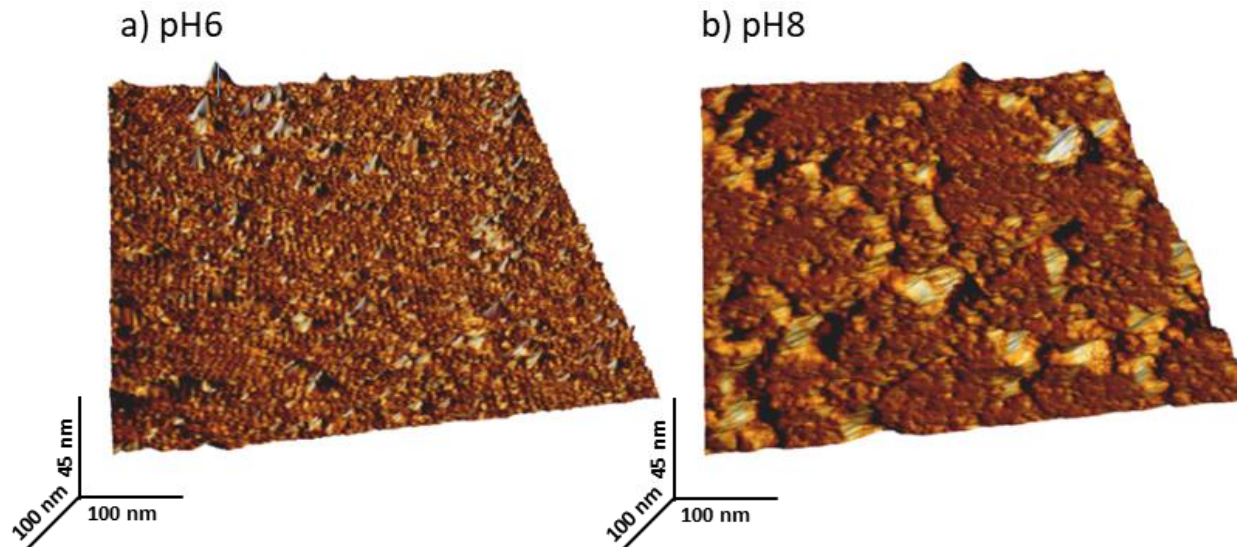
It seems that the flocculation mechanism is different depending on the pH!

AFM reveals the flocculation mechanisms involved



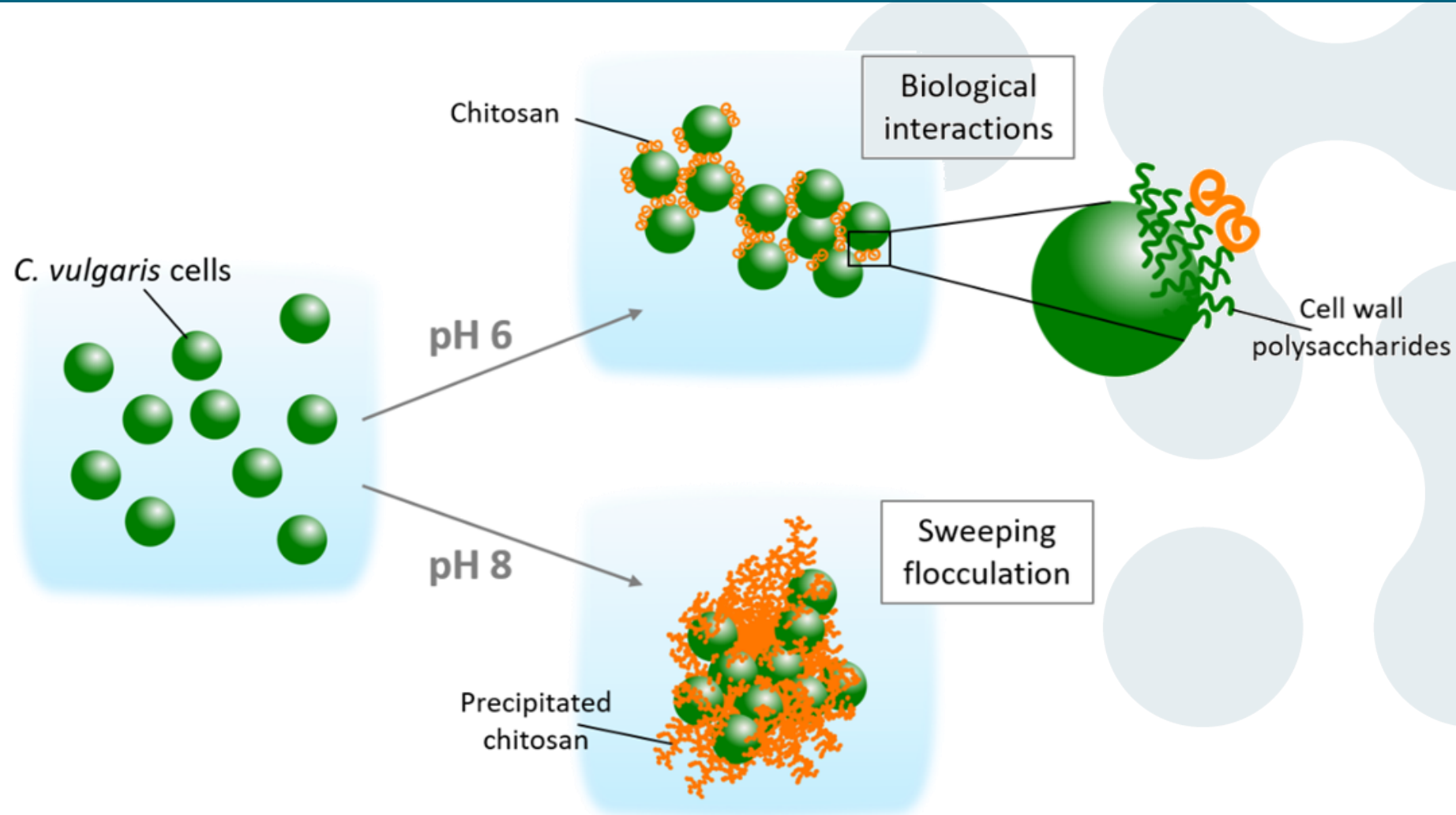
Molecular unfoldings at pH 6 only!

- Identification of a new flocculation mechanism based on specific interactions between chitosan and polymers from microalgae cells



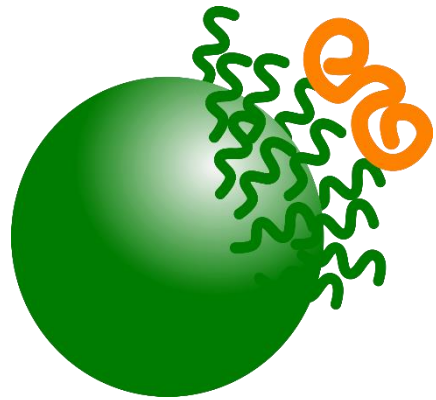
At pH 8, chitosan precipitates and does not interact with cells anymore

AFM reveals the flocculation mechanisms involved



➤ **The flocculation mechanism depends on the pH!**

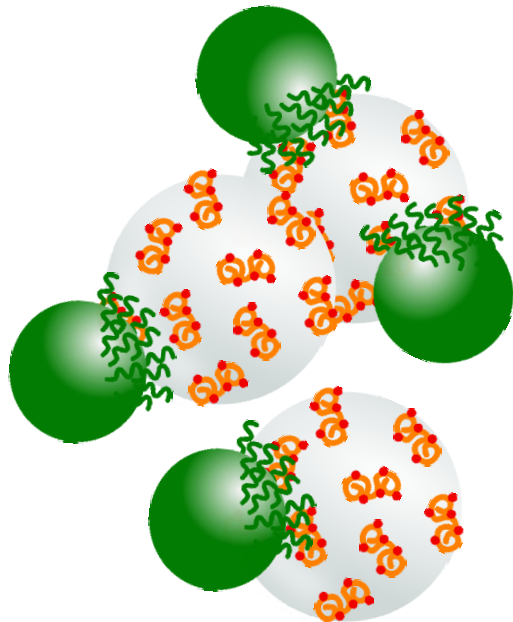
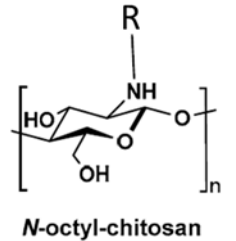
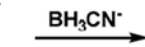
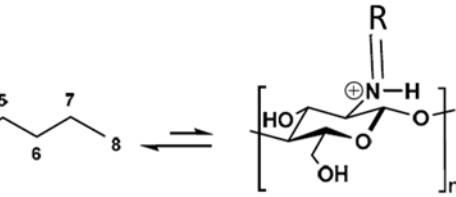
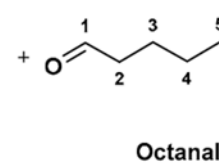
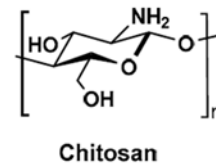
Going a step further: flotation without flocculation



At pH 6, cells interact with chitosan



Make chitosan amphiphilic
polyoctyl chitosan



Bubble interface engineering

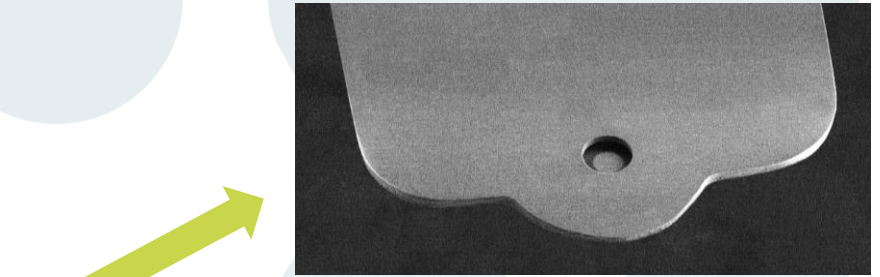
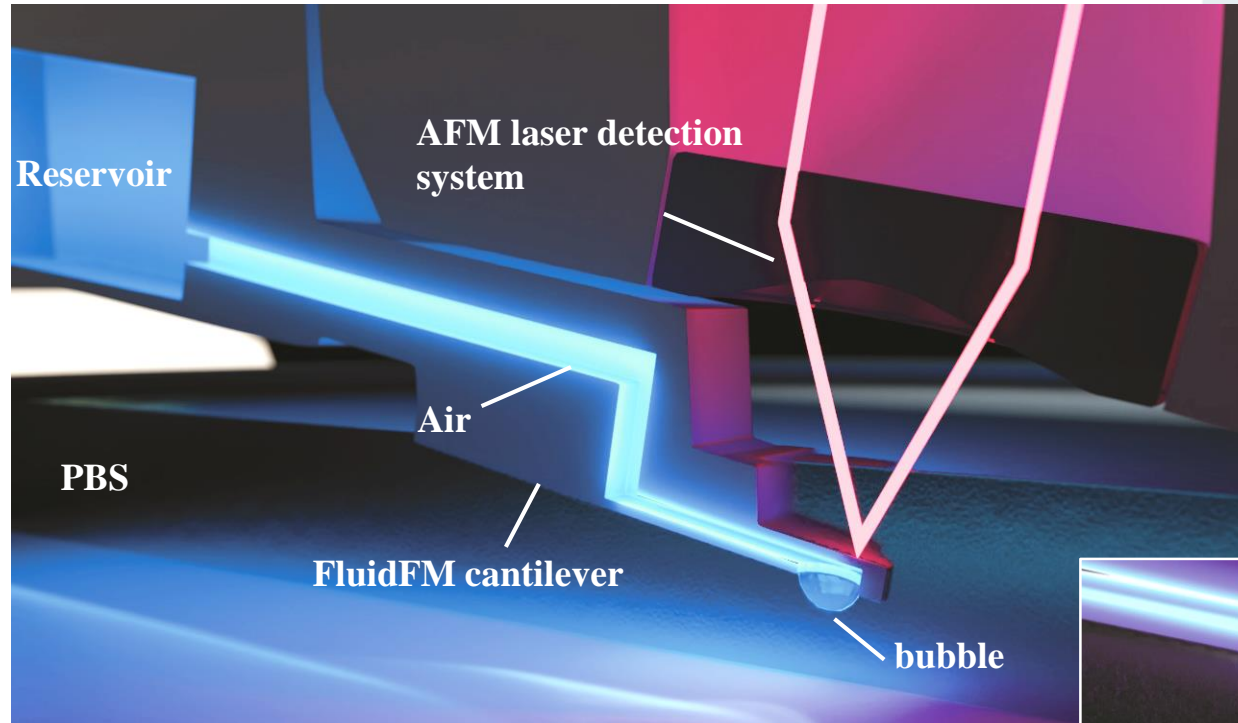
Flotation with functionalized bubbles that bind cells directly without a flocculation step



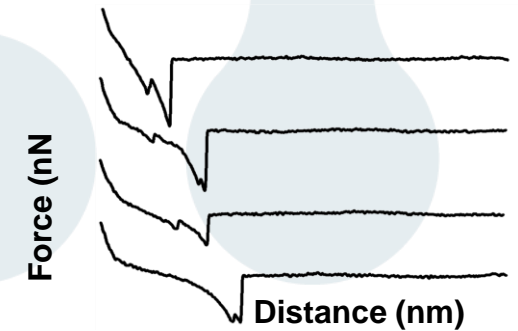
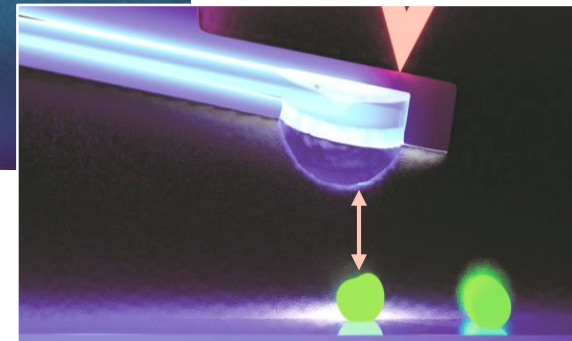
➤ Will functionalized bubbles interact with cells?

➤ We need to find a way to probe the interactions between bubbles and cells

FluidFM to produce bubbles and measure interactions



Probe the biophysical properties of bubble-cell interactions



We use FluidFM in an original manner to produce bubble directly at the aperture of microchanneled cantilevers

FluidFM to produce bubbles and measure interactions

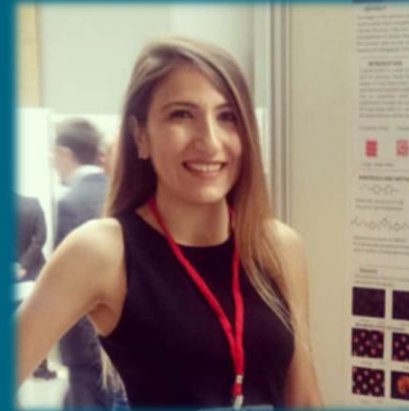


We use FluidFM in an original manner to produce bubble directly at the aperture of microchanneled cantilevers

Acknowledgements



TIM team of TBI



Irem Demir



Jonas Blockx



Thank you for your attention!

