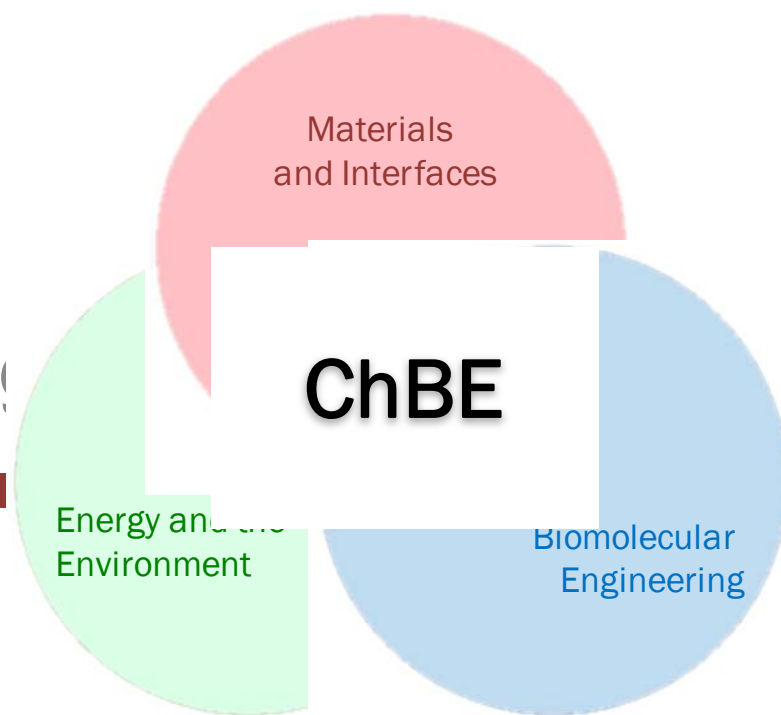


Undergraduate Research Opportunities

Department of Chemical
Biomolecular Engineering



Research for Pay: The EXCEL Scholars Program

- Enables high-performing students to **assist faculty members with their scholarship.**
- **Encourages collaboration in learning between faculty and students.**
- Student work must be research- oriented and not administrative in its primary emphasis.
- EXCEL Scholars may work part-time during the academic year or full-time during the Summer and the Interim Session.
- Participation in the EXCEL Program is an honor reserved for those who have achieved academic distinction.
 - Students must have completed their first year at Lafayette with a cumulative GPA maintained above 3.25

Research for Pay: Clare Booth Luce Scholars Program

- “Since it’s inception in 1989, the Clare Boothe Luce Program has been one of the most significant sources of support for women seeking to study or teach science, engineering, and mathematics.”
- Participation in the CBL Program is an honor reserved for **female** students who have achieved academic distinction in **engineering** at Lafayette.
 - To be eligible, students have completed their first year at Lafayette, be a US Citizen, and should maintain a cumulative GPA maintained of 3.25
- Students should contact participating faculty and will be asked to write a personal statement and get a letter of recommendation to be submitted to the Engineering Division

Research for Credit: CHE 392/393: Independent Research

- Independent Research in Chemical Engineering serves to provide students with a **high quality *hands-on student-faculty research experience*** for a range of technical topics. Before registering, a research proposal must be submitted to a faculty member who serves as the adviser and to the Scholarship Committee for approval. Each student is required to submit a course Portfolio for course credit.
- Course Hours:
 - One hour per week meeting with Instructor (minimum)
 - Ten hours per week course work (minimum)
- CHE 392/393 satisfies a free elective in chemical engineering.

Research for Credit: CHE 495/496: Honors Thesis

- An Honors Thesis in Chemical Engineering serves to provide outstanding students with a **high quality student-faculty research experience during the senior year**. Candidates for honors must have and must maintain a cumulative GPA of 3.00 and ChBE Departmental GPA of 3.20. The specific research topic of the Honors Thesis should be discussed well in advance of the senior year with the Instructor.
- Course Hours:
 - One hour per week meeting with Instructor (minimum)
 - Ten hours per week course work (minimum)
- CHE 496 satisfies a chemical engineering elective.

Professor Polly Piergiovanni

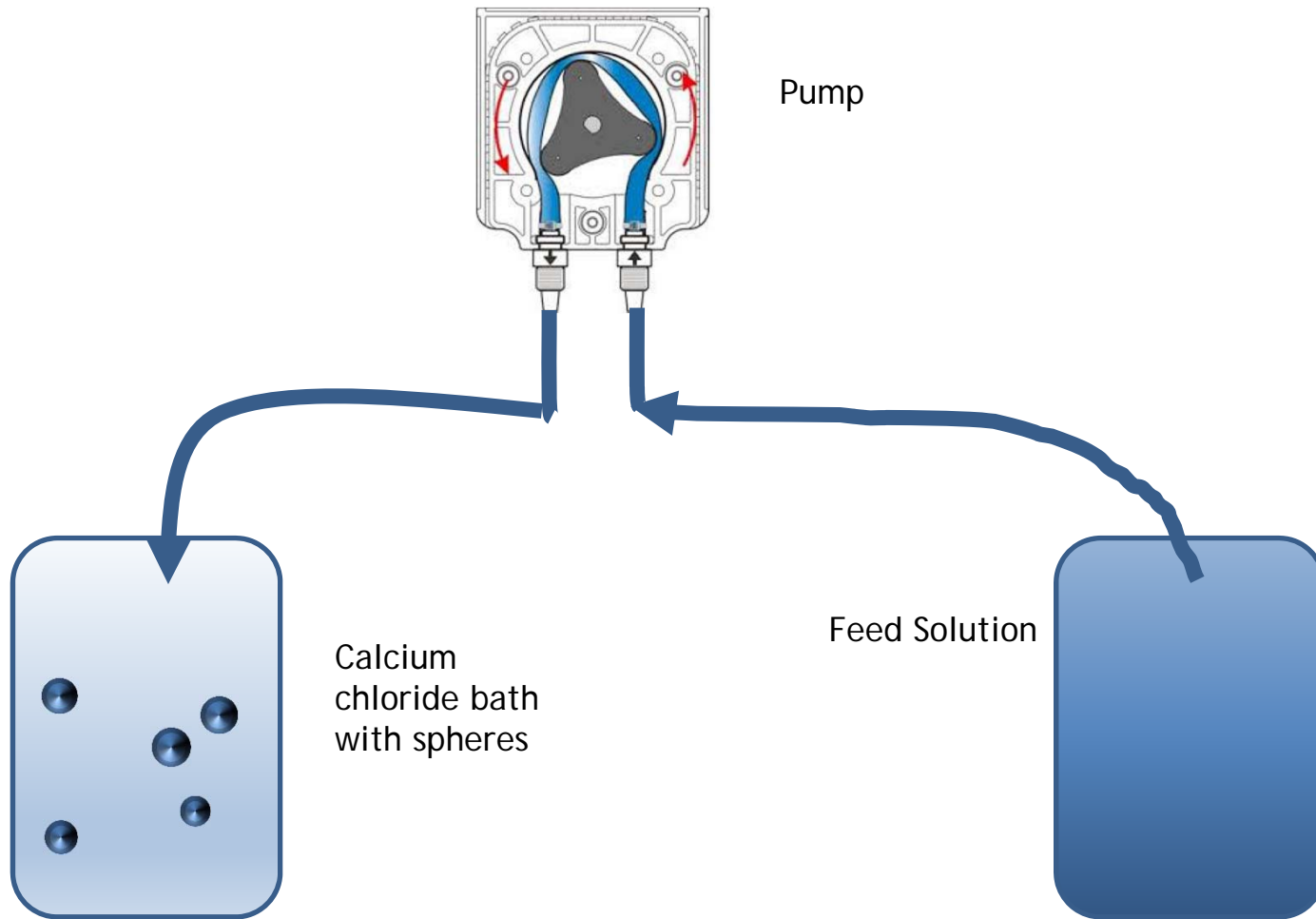
- Engineering Education
- Food Science and Engineering



CEE

chemical engineering education

Spherification Automation



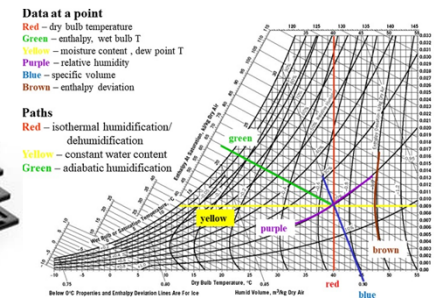
Piergiovanni - Research Interests



Starch gelatinization



Dehydration



<https://ars.els-cdn.com/content/image/1-s2.0-S1749772817300258-gr>



Chocolate tempering

Availability

Independent Study (Spring '19)

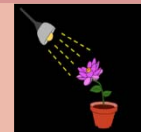
Engineering Bio-inspired Polymers

Polymers touch nearly every aspect of our everyday lives



Motivated by Nature

Phototropism



Contraction of pupils
in response to light



Healing after a cut

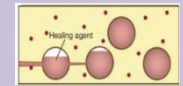


Strengthening of
bone



For Many Applications

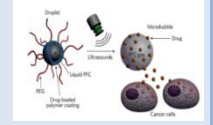
Self-Healing
Materials



Responsive
Coatings



Controlled Drug
Delivery



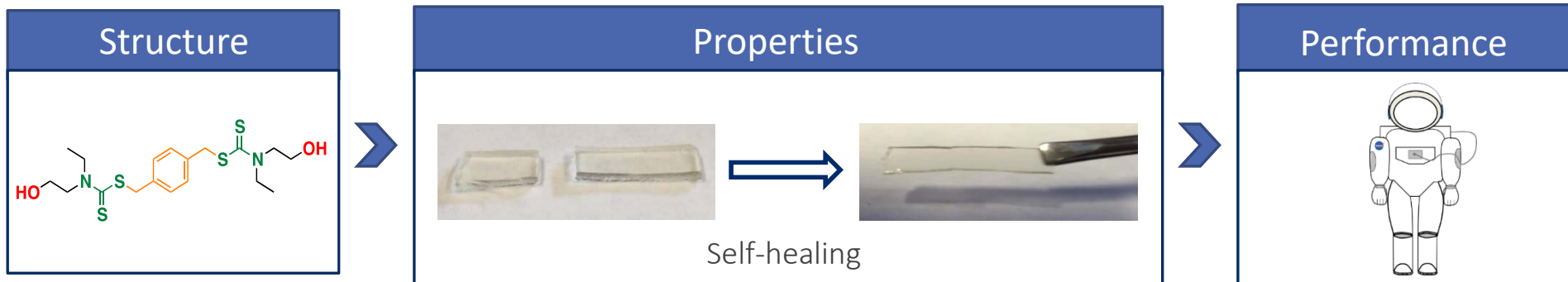
Shape Memory
Materials



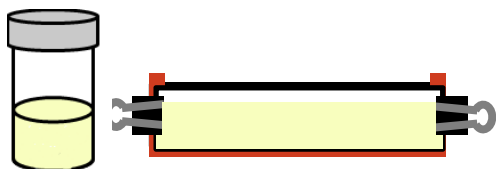
M. A. C. Stuart, W. T. S. Huck, J. Genzer, M. Muller, C. Ober, M. Stamm, G. B. Sukhorukov, I. Szleifer, V. V. Tsukruk, M. Urban, F. Winnik, S. Zauscher, I. Luzinov, S. Minko, *Nat Mater* **2010**.
O. Azzaroni, A. A. Brown, W. T. S. Huck, *Angew Chem Int Edit* **2006**.
S. R. White, N. R. Sottos, P. H. Geubelle, J. S. Moore, M. R. Kessler, S. R. Sriram, E. N. Brown, S. Viswanathan, *Nature* **2001**. S. Mura, J. Nicolas, P. Couvreur, *Nat Mater* **2013**.

Development & Characterization of Polymer Networks

Overall Theme:



Techniques:



Network Formation



Stereolithography 3D printing



Dynamic Mechanical Analysis

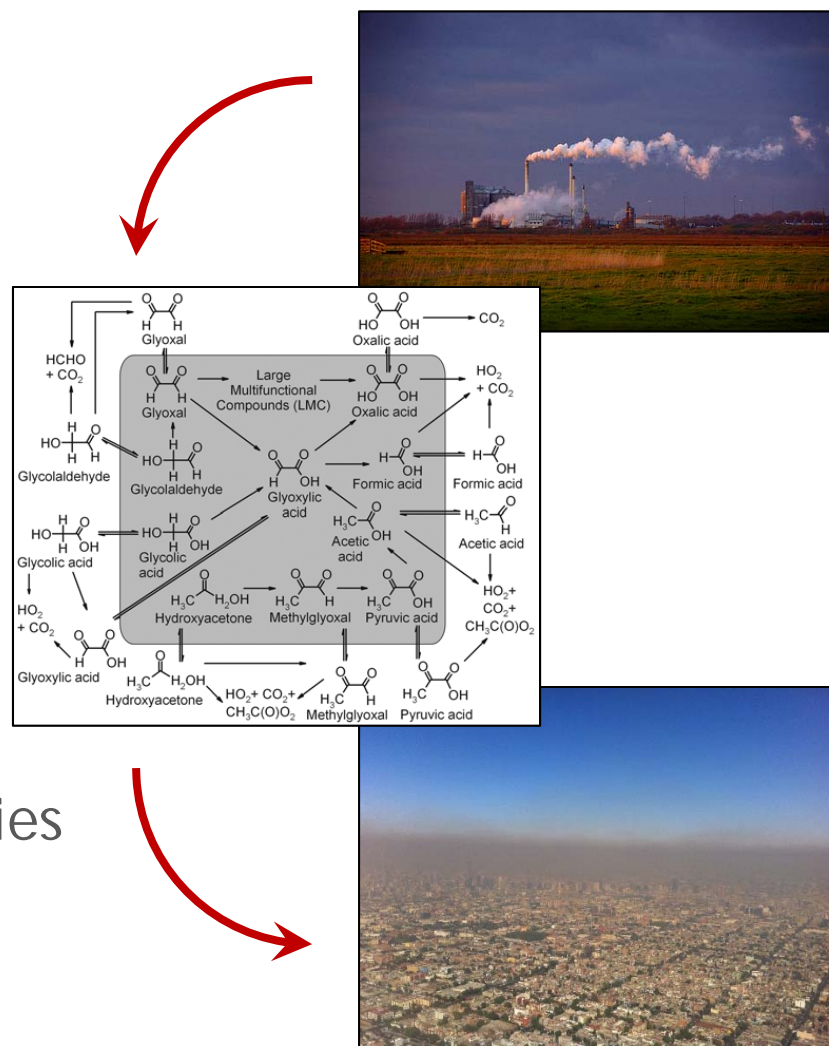
ATMOSPHERIC AEROSOL CHEMISTRY

Impetus:

Accurate prediction of organic aerosol chemistry is crucial to understand its **effect on atmospheric chemistry** and overall **contribution to climate energy balances**.

What we need to know:

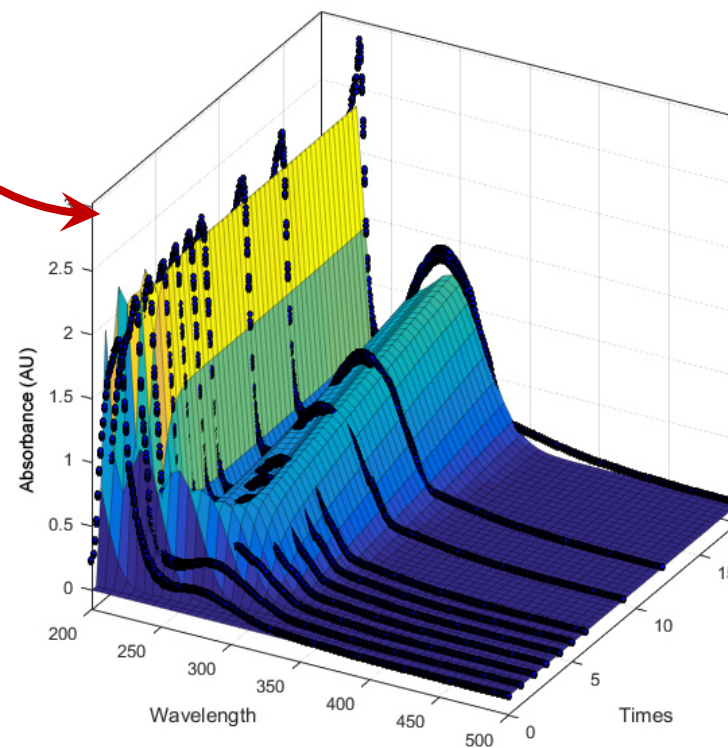
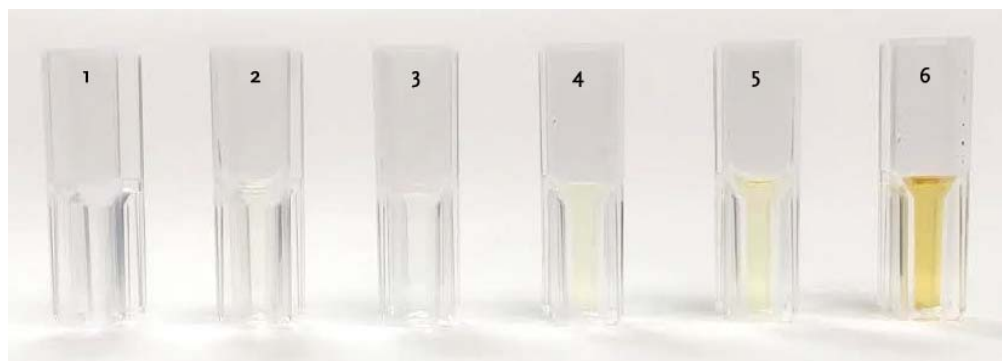
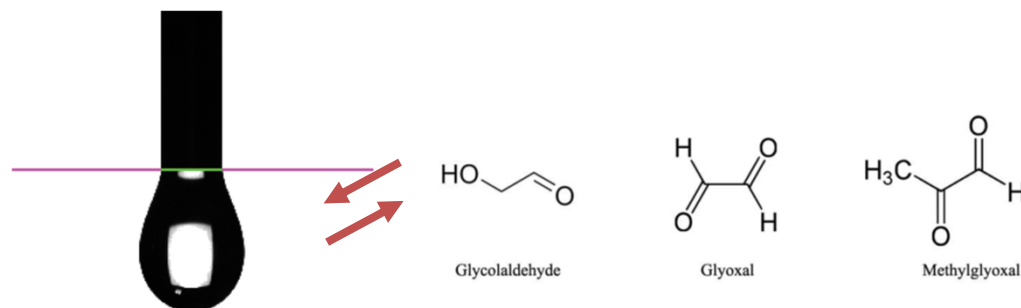
- Relative **rates of formation**
- Direct **light absorbance** properties
- Indirect **surface tension (cloud activating)** properties



ATMOSPHERIC AEROSOL CHEMISTRY

Experimental Work:

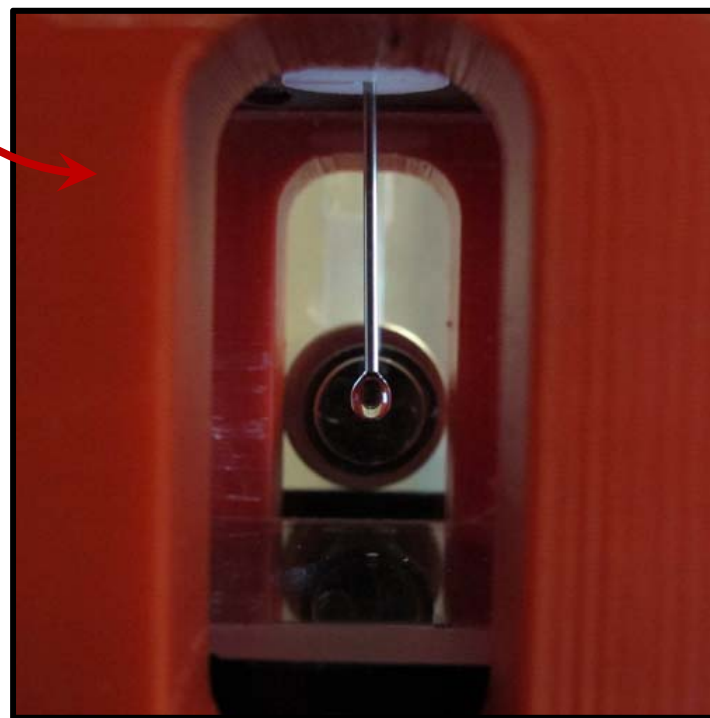
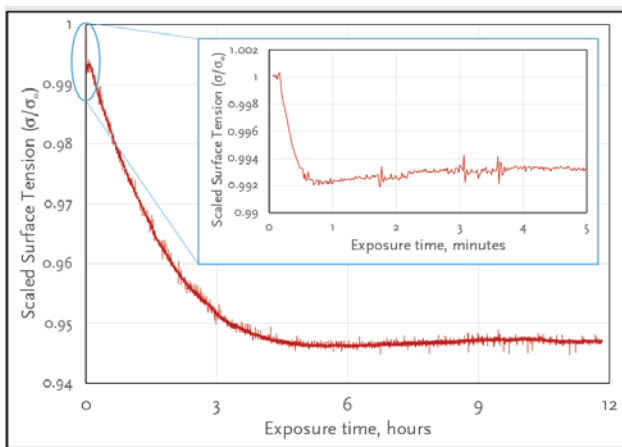
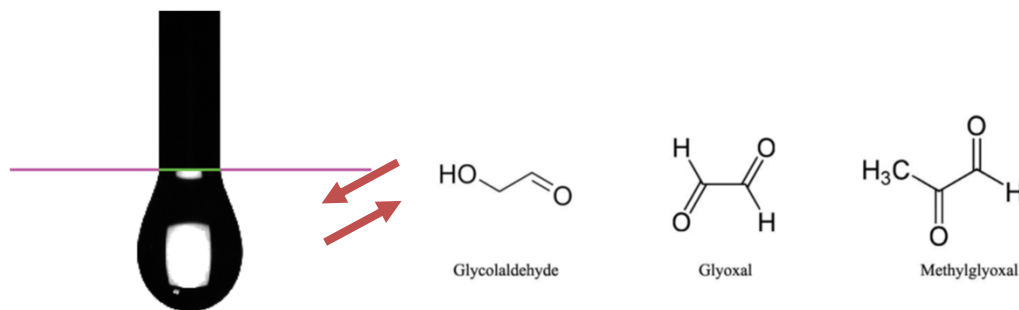
- Aerosol droplet mimic characterization
- Measurement of light-absorbing organic-ammonium cross-reactions



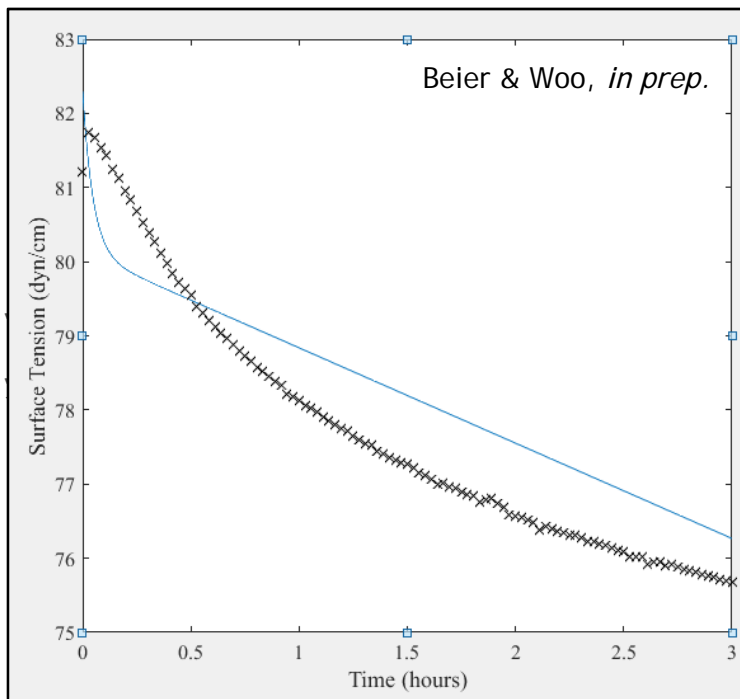
ATMOSPHERIC AEROSOL CHEMISTRY

Experimental Work:

- Aerosol droplet mimic characterization
- Measurement of light-absorbing organic-ammonium cross-reactions
- Dynamic surface tension studies of water-soluble volatile organics



ATMOSPHERIC AEROSOL CHEMISTRY



Computational Work:

- Refinement and improvement of **mass uptake** coefficients, **reaction rate** constants
- Compilation of data to predict **wider ranges of pollutants/emissions**
- Aerosol **absorbance and surface tension models** from experiments

Experimental Skills:

- UV/visible spectroscopy
- LabVIEW programming / instrumentation
- MATLAB programming / model development

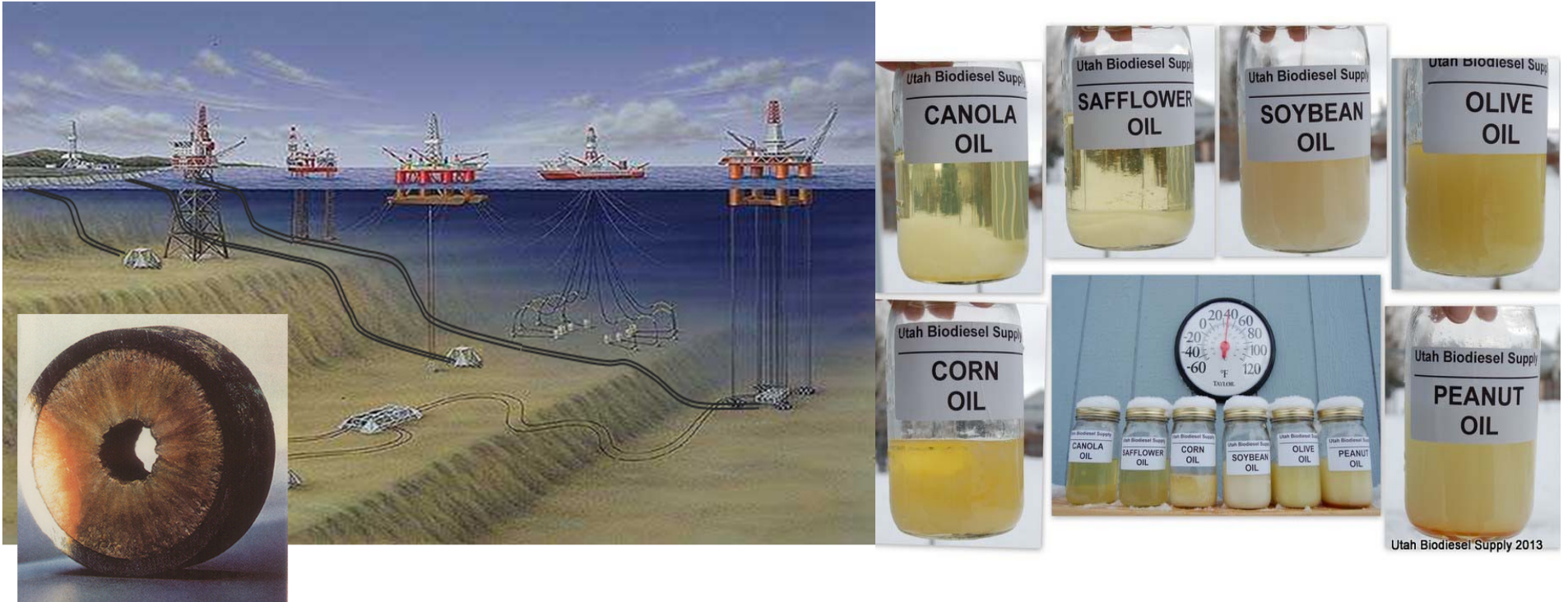
*Research opportunities
are available!*

Getting Things Moving: Studying Cold Flow Properties

- As the name indicates, studying how fluids move at low temperatures
- Particular interest: fuels
- What can happen?
 - Changes in viscosity
 - Changes in phase (liquid → solid)
 - Leads to gel formation



Where Is This Issue Seen?



- **Petroleum:** Subsea oil transportation
- **Biodiesel:** Engines and other equipment
- Fuel composition crucial for understanding

Equipment/Skills

- Conducting measurements of flow properties important in the energy industry.
- Rheometry
- Differential scanning calorimetry

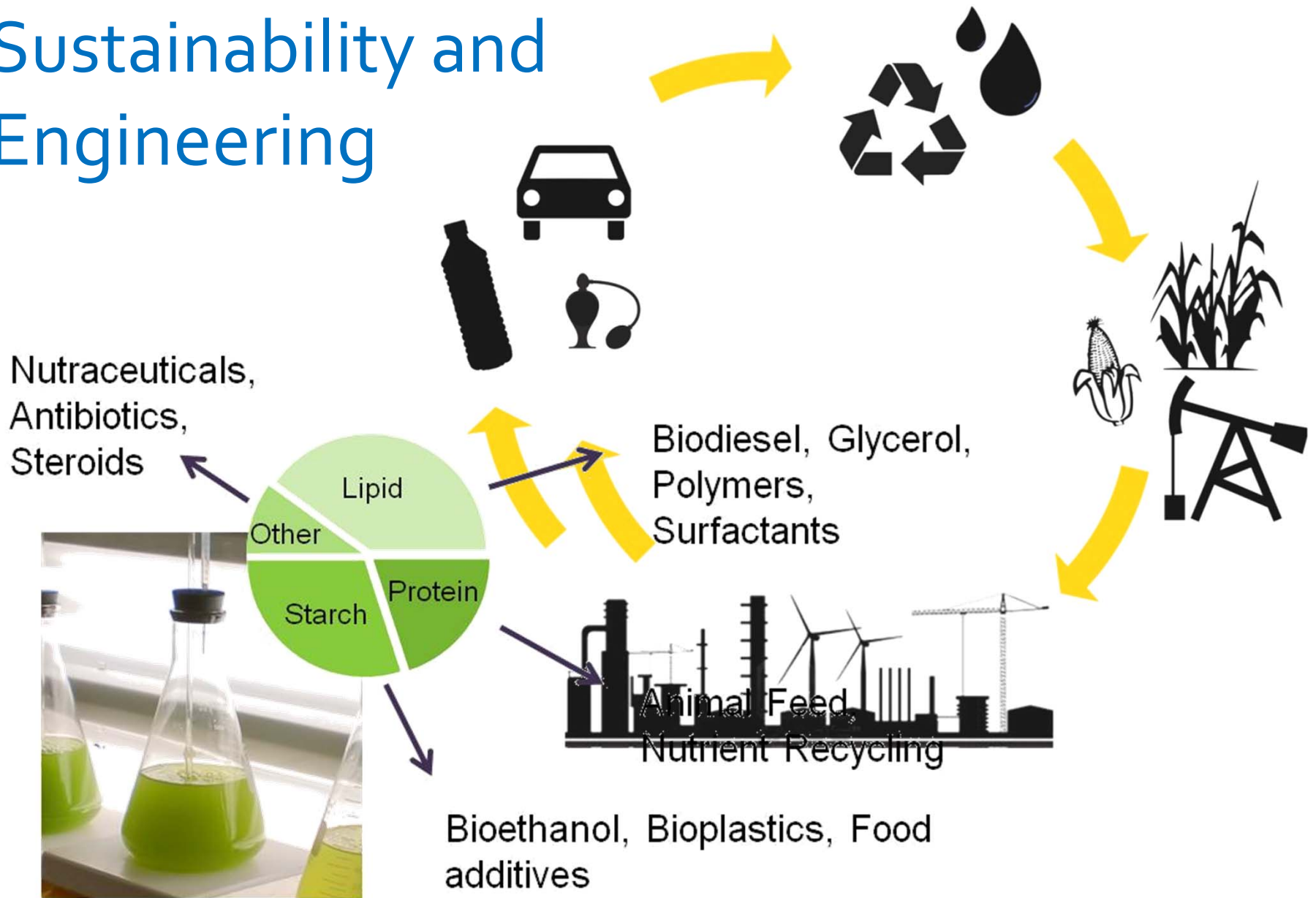


Opportunities available:

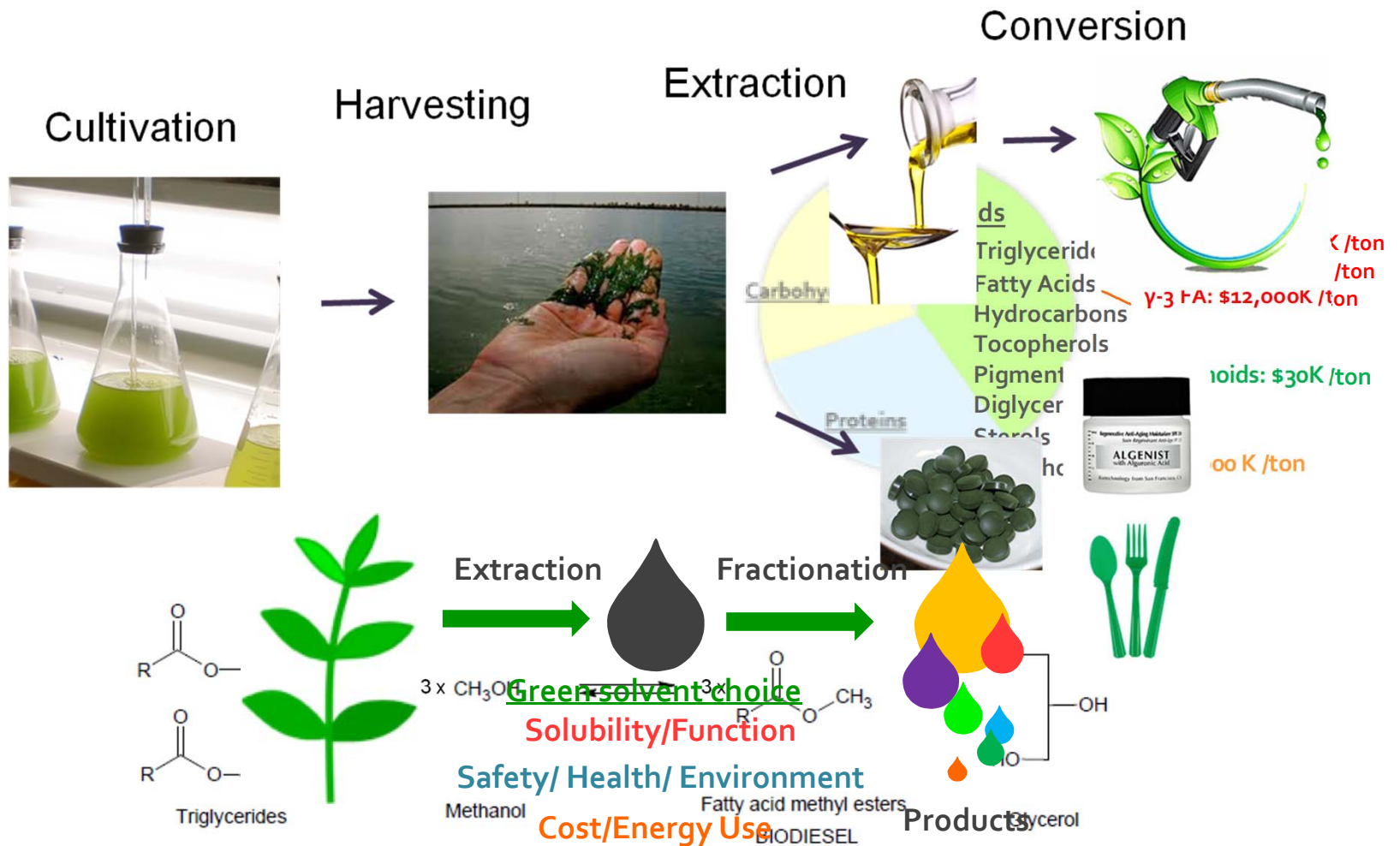
EXCEL and CBL scholars (SU 18 and AY 18-19)

Honors Thesis and Independent Study (AY 18-19)

Sustainability and Engineering



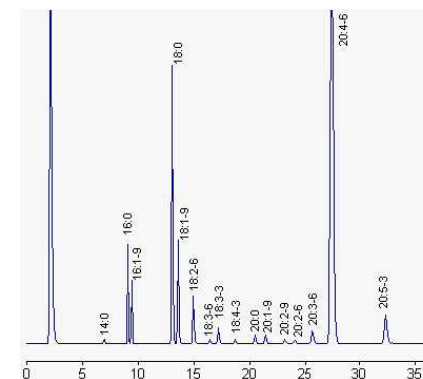
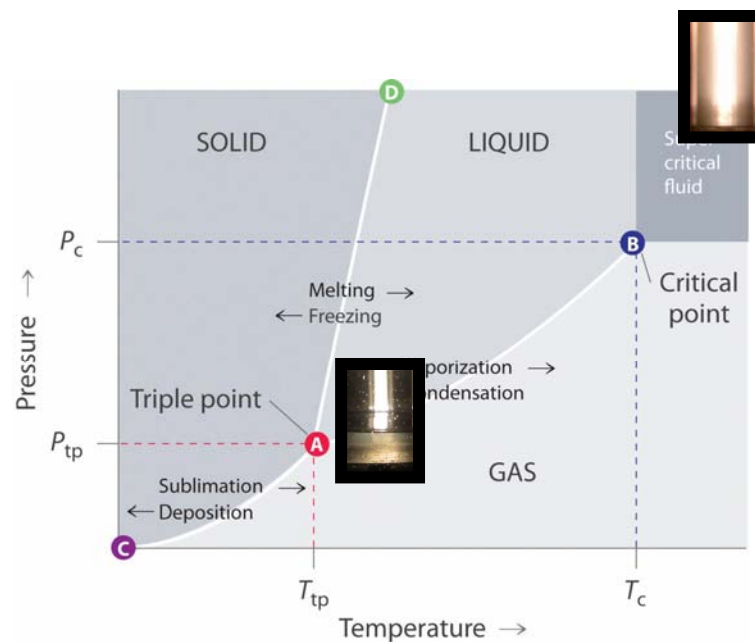
Biodiesel Production Process



Skills and Availability

Skills

1. Experimental Design
2. Reactions at ambient and supercritical conditions
3. Analysis with (Gas/SCF) chromatography
4. Biomass extraction

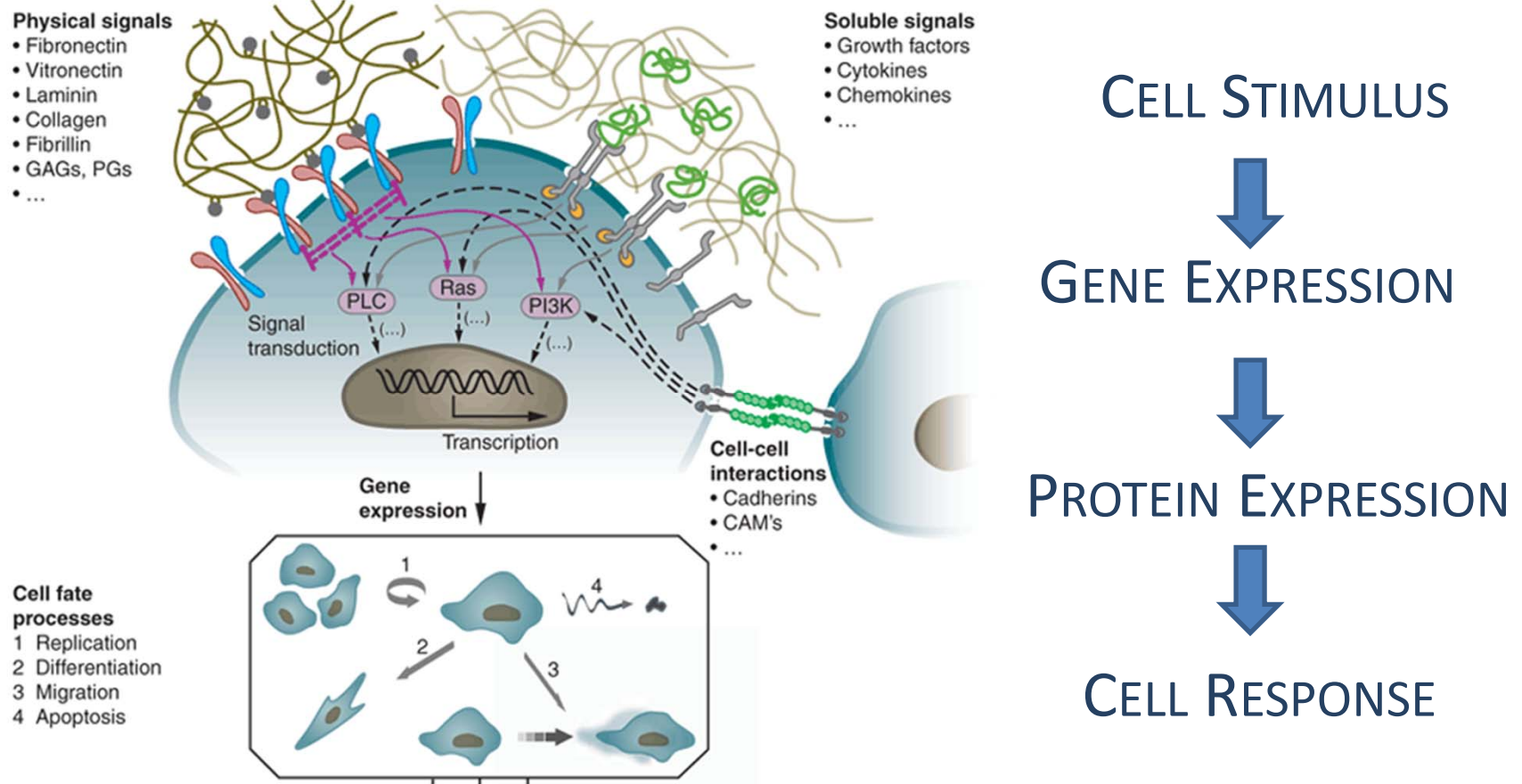


Availability

Excel Scholar/CBL (SU18, AY17-18)
Honor's Thesis/Indep Study (AY18-19)

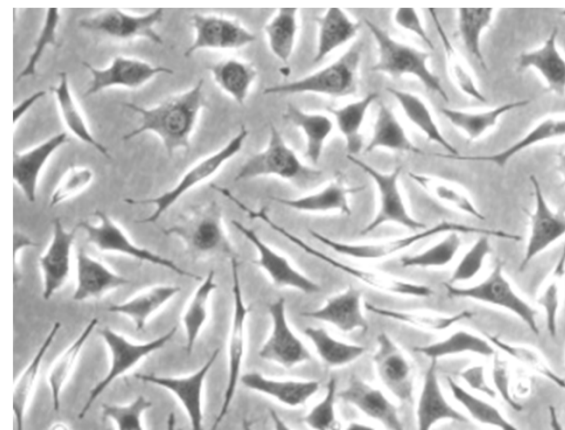
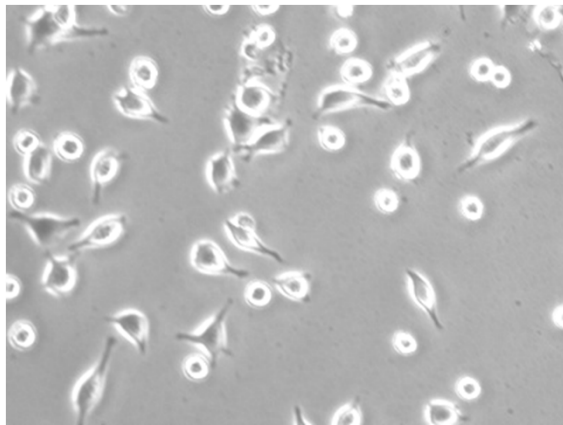
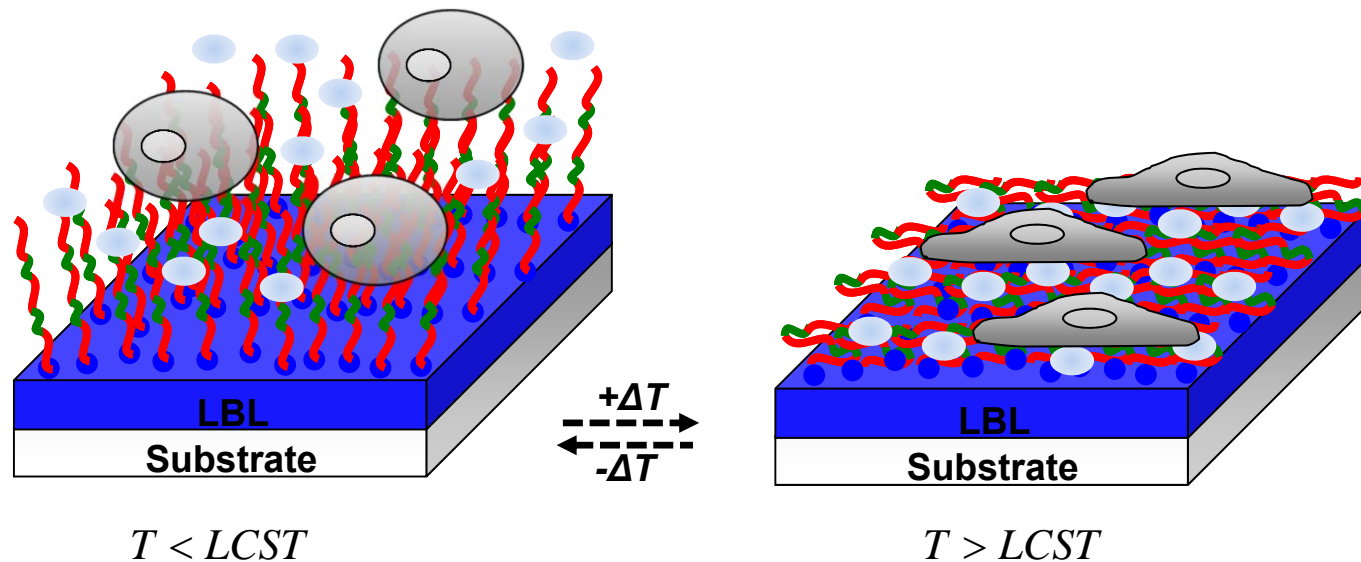


Investigation of protein expression and cell function in biomolecular engineering applications

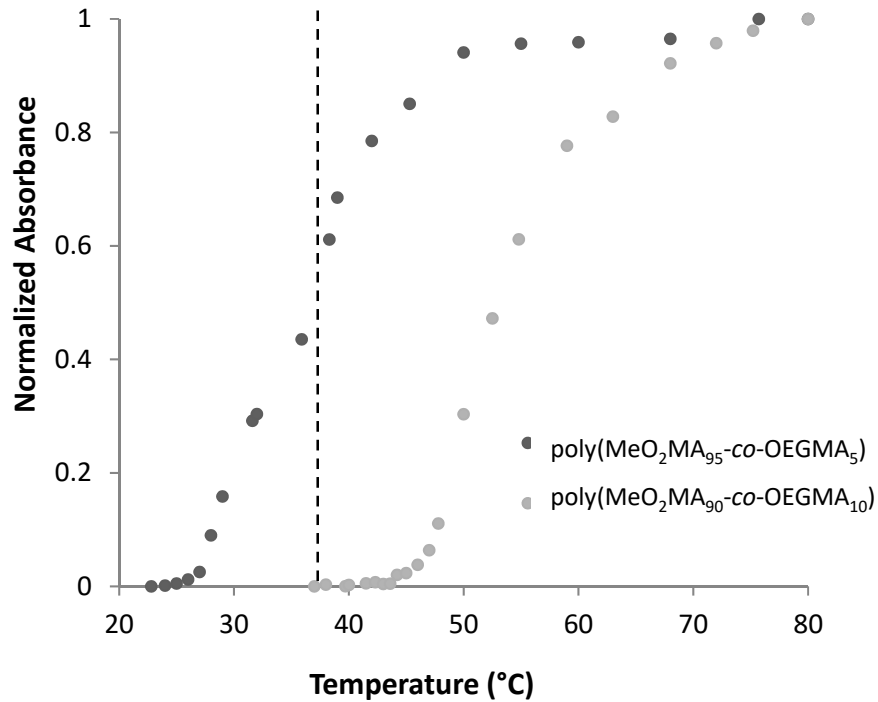


Central question: How does the regulation of cell protein expression affect cell function and inform the engineering of better materials?

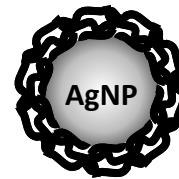
Protein Adsorption and Cellular Responses to Thermoresponsive Polymer Substrates



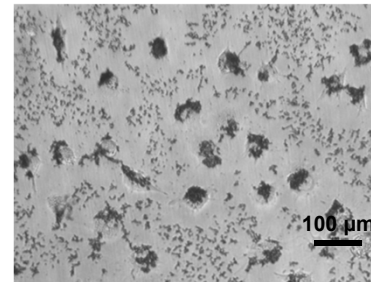
Cellular Responses to Functionalized Nanoparticles



Ag-(MeO₂MA₉₅-co-OEGMA₅)

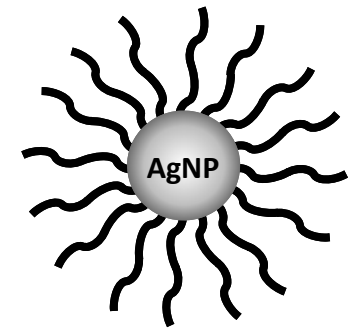


T > LCST @ T = 37°C

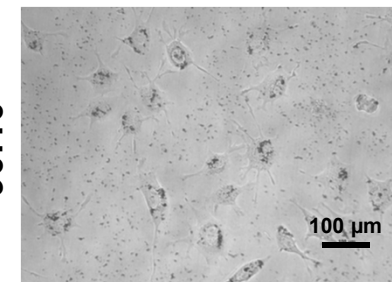


95:05

Ag-(MeO₂MA₉₀-co-OEGMA₁₀)



T < LCST @ T = 37°C



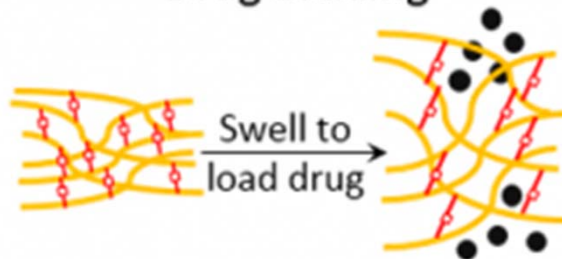
90:10

Biomaterials for Drug Delivery and Tissue Engineering

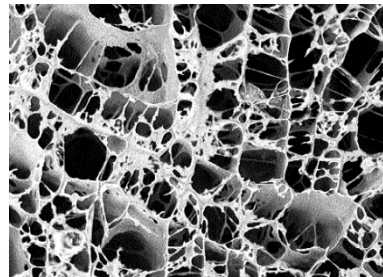
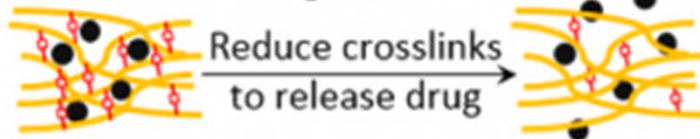
Polymer Matrix Formation



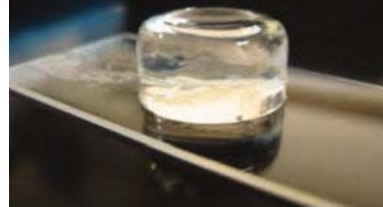
Drug Loading



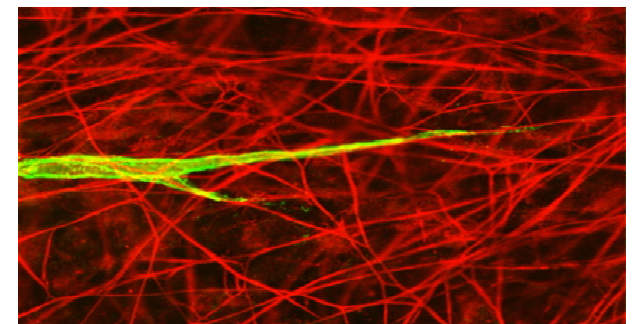
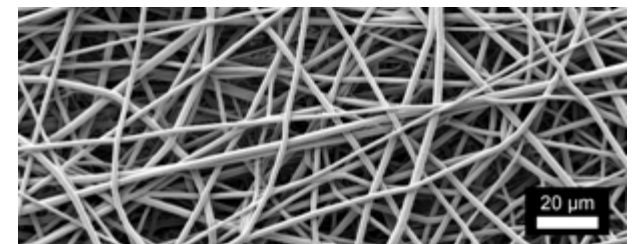
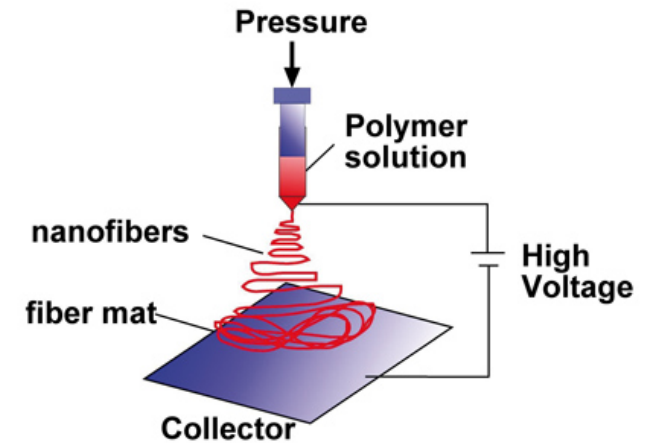
Drug Release



A Hydrophilic



B Hydrophobic



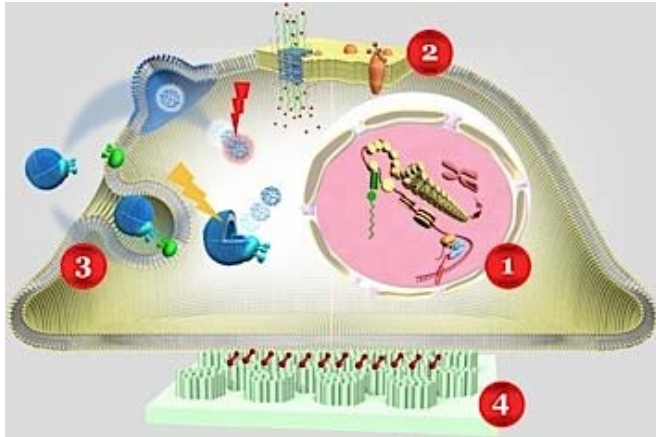
Experimental skills:

- Sterile cell culture
- Immunohistochemistry
- Confocal microscopy
- Protein adsorption assays
- Fluorescence spectroscopy
- In vitro cell function assays

Availability:

- Honors Thesis: AY 2018-2019 (Juniors)
- EXCEL/CBL: AY 2018-2019 (Soph/Juniors)

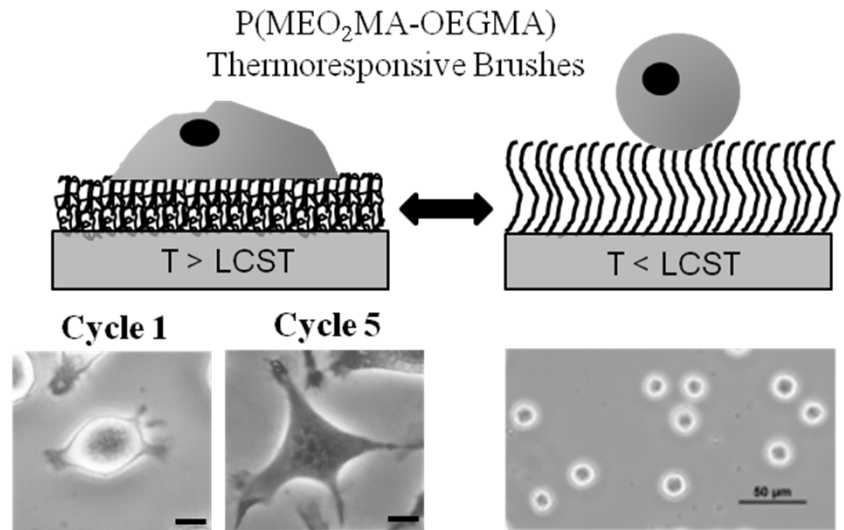
Engineering the cell-surface interaction



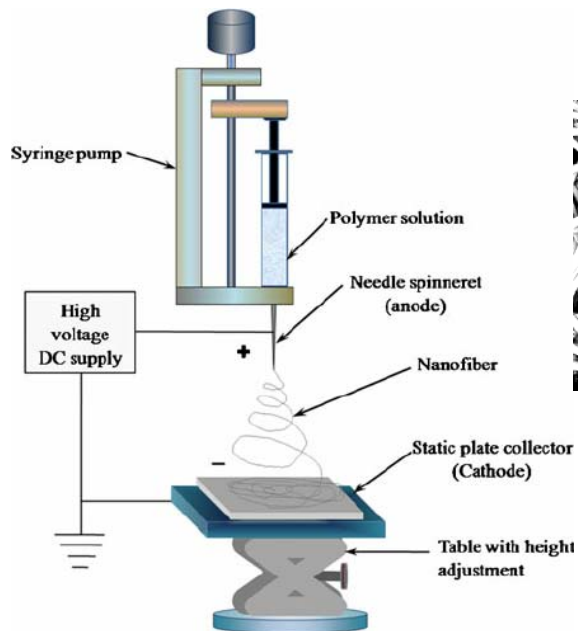
DNA → RNA →
PROTEIN

- **Overarching principle:** *Manipulate biomaterial properties, (bulk: modulus; surface: chemistry, topography), to selectively control the cell-material interaction.*
- For the relevant cell type, evaluate the following parameters on the biomaterial:
 - Cell morphology: microscopy, image analysis (spreading, circularity)
 - Cell adhesion: microscopy, immunofluorescence, adhesion assays
 - Cell differentiation: gene and protein expression, soluble signaling
 - Cell proliferation: DNA quantification
 - Cell-vitality: live/dead quantification using ViCell

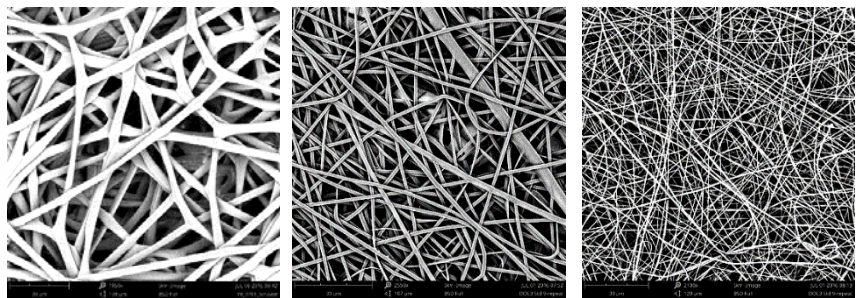
Thermoresponsive Polymers and Cell Culture



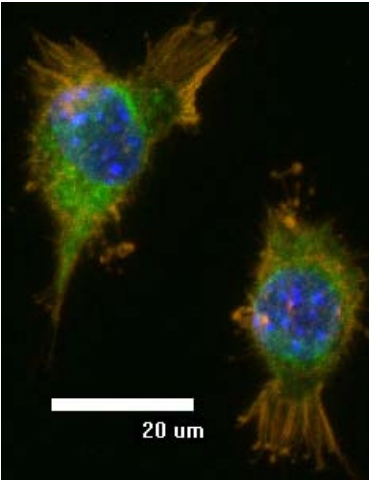
Process of Electrospinning



Optimizing Polymer Nanofibers for Cell Culture Applications



Cell Morphology by Confocal Microscopy





What skills will I learn?

- Sterile cell culture
- Microscopy (phase contrast, confocal)
- Polymer fabrication (nanofibers, microspheres, 2D films)
- UV-vis spectrophotometry
- Gene expression

What positions are open?

- Summer 2018: Team of 2
 - Clare Boothe Luce Scholars
 - EXCEL Scholars
- Will be on sabbatical in Fall 2018

I'm interested – what do I do next?

- **Summer EXCEL and CBL Scholars (pay)**
 - SU18: Talk to faculty ASAP
 - Deadlines: Excel - March 5. CBL - February 27
 - AY 18/19: Decision by late summer
- **Independent Research (credit only) AY 18/19:**
 - Limited to faculty availability; discuss with faculty over the summer.
- **Honors Thesis (seniors only, credit only)**
 - Plan early
 - For non-seniors, get research experience