Colonial Chemical

Surfactants 101

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WASH YOUR HANDS

Outline

- What is a Surfactant?
- Key Surfactant Properties
- Surfactant Rheology
- Types of Surfactants
  - Anionic
  - Cationic
  - Amphoteric
  - Nonionic
- Future of Surfactants
- Going Sulfate-Free

What is a Surfactant?

- Surfactant = Surface Active Agent
  - *"A chemical compound which when dissolved or dispersed in a liquid is preferentially adsorbed at an interface, lowering surface tension or interfacial tension."*

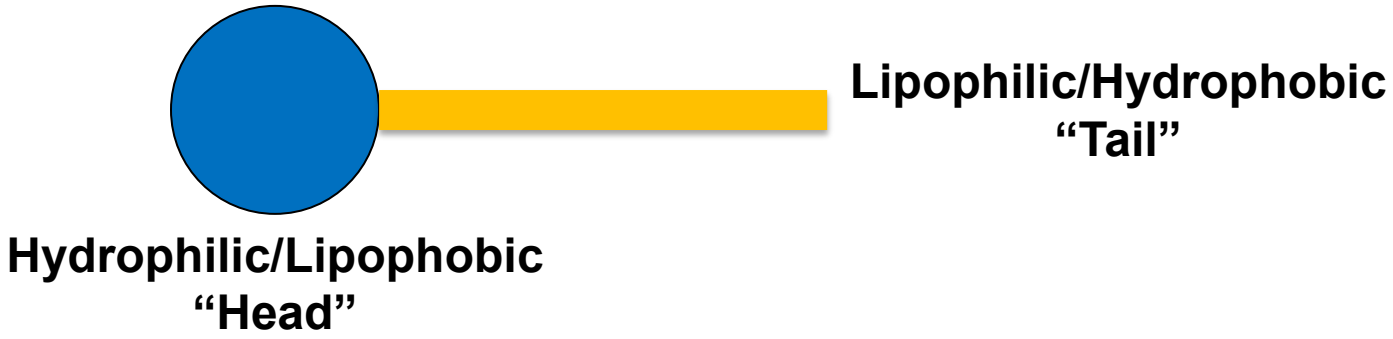
- Surfactants:
  - Make oil and water mix
  - Make water wetter

What are Surfactants Good For?

- Wetting
- Foaming
- Dispersion
- Lubrication
- Detergency
- Paper sizing
- Solubilization
- Emulsification

How Surfactants Work

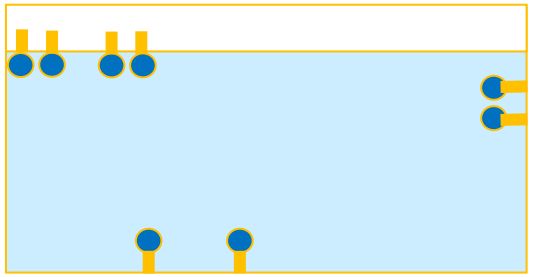
- "Tadpole" structure is key to functionality



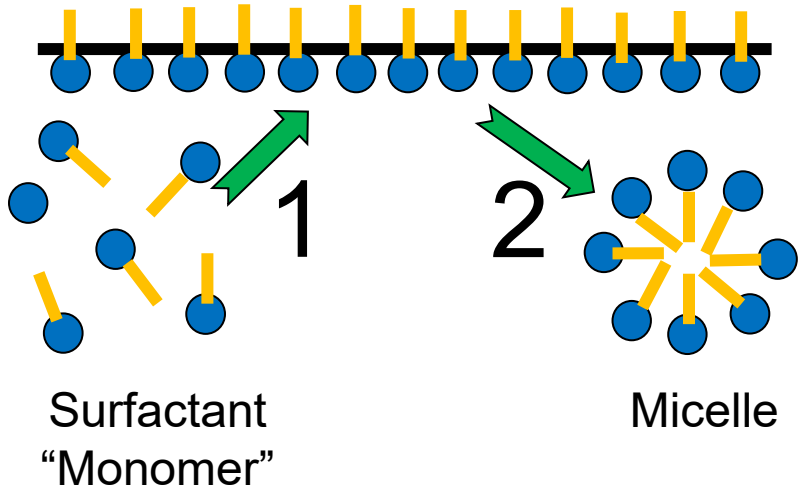
- Relative and absolute sizes of groups dictates function

Micelle Formation

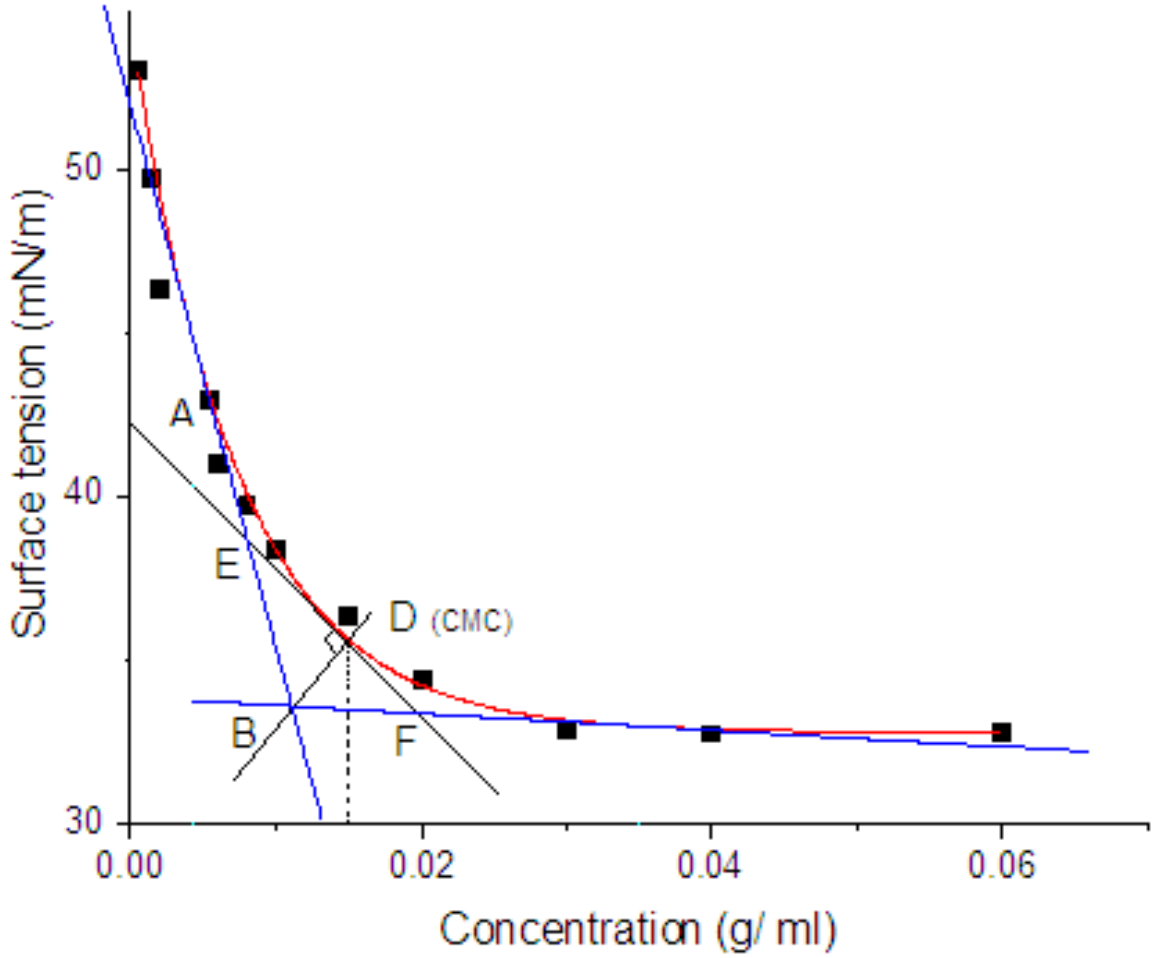
- At low concentrations, surfactants migrate to the edges of the water



- Once the surfaces are filled, surfactants assemble into spheres

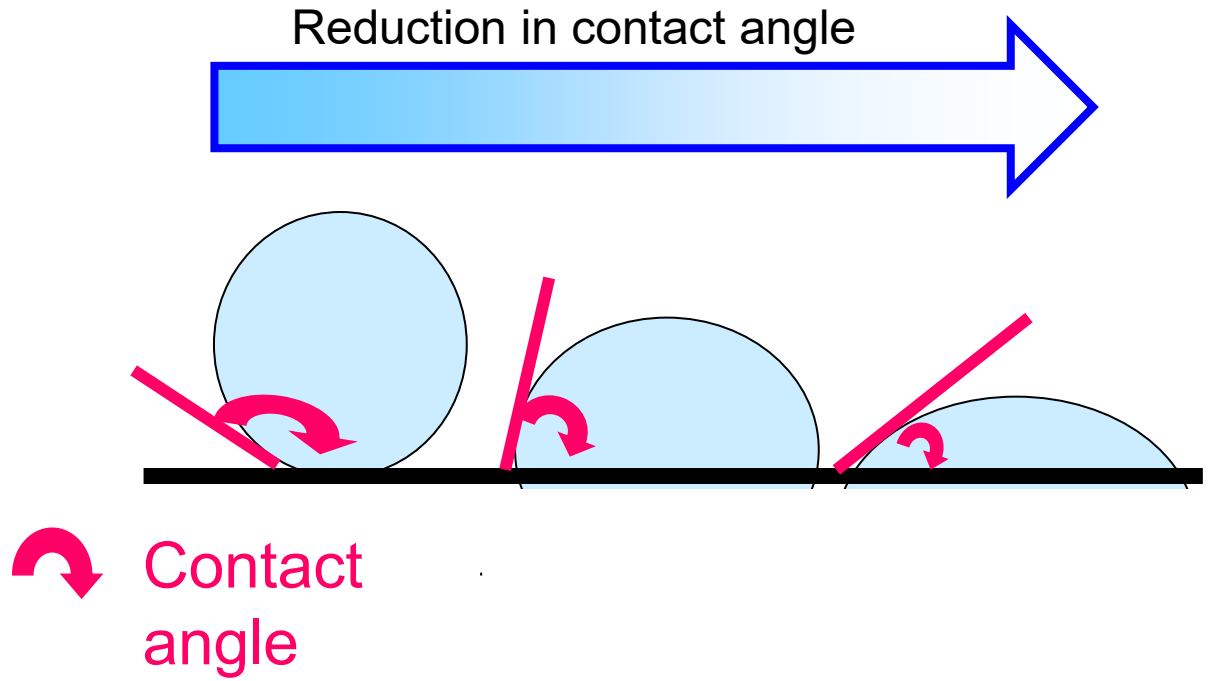


Critical Micelle Concentration



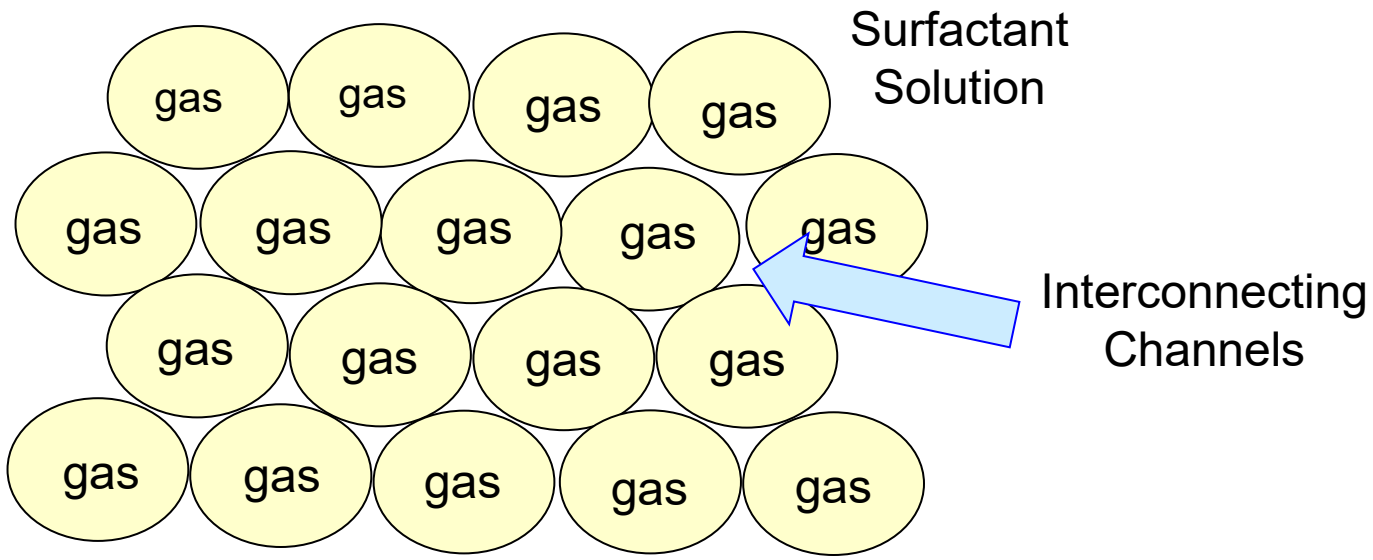
Surfactant Wetting

- Surfactants reduce surface tension of water
- As a result, water droplets spread out over a surface more effectively



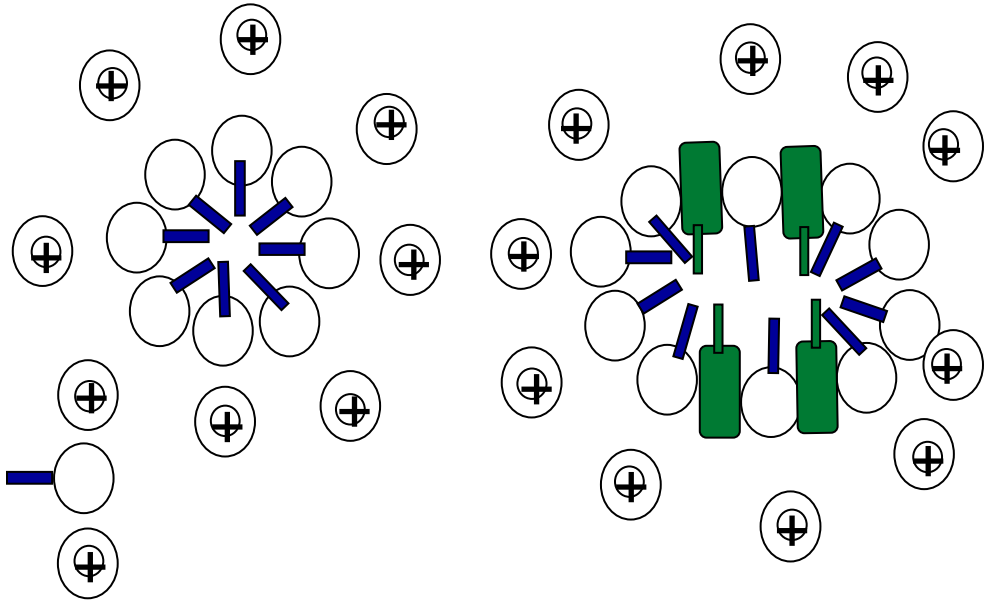
Foam

- For majority of applications, foam is strictly aesthetic
- Mixed surfactants solutions exhibit improved stability
- Surfactants which improve viscosity also improve foam appearance
  - Shrink bubbles
  - Slow drainage



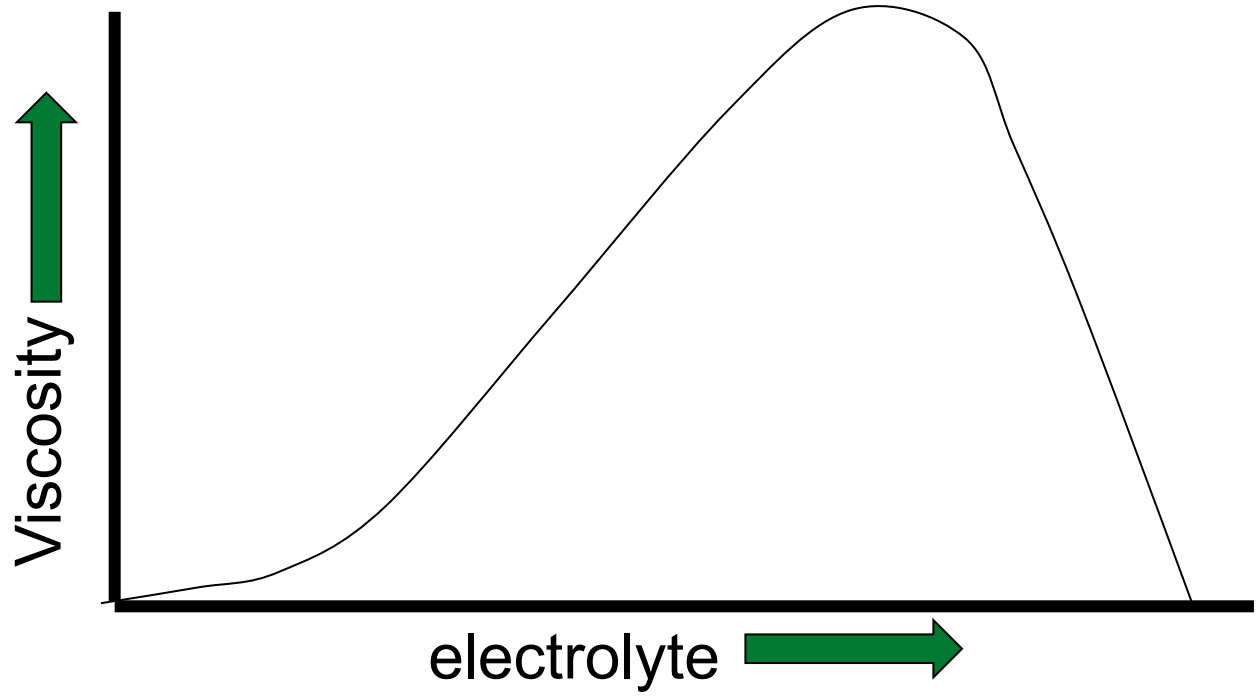
Surfactant Thickening

- Micelles can contain dozens or thousands of surfactant “monomers”
- As surfactant concentration increases, new micelle shapes can form
- Charged hydrophilic “heads” are kept apart by electrostatic repulsion
  - Salt reduces electrostatic repulsion
  - Nonionic surfactants (amides) increase packing



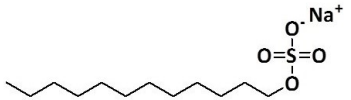
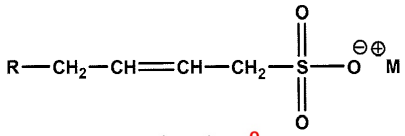
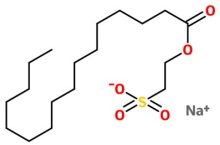
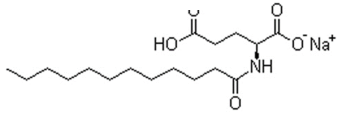
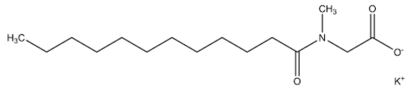
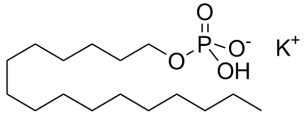
Surfactant Thickening

- Surfactant packing dictates micelle shape and size
- Micelles are always in flux
- Over-salting reduces viscosity



Types of Surfactants

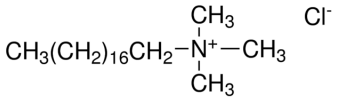
- Anionic
  - Most detergent surfactants
  - High foaming for personal care
  - Combine with amphoteric surfactants for optimum aesthetics

- Sulfate 
- Sulfonate 
- Isethionate 
- Glutamate 
- Sarcosinate 
- Phosphate 

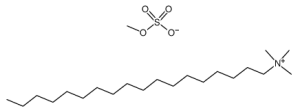
Types of Surfactants

- Cationic
  - Most conditioning agents
  - Typically moderate or low foaming
  - Variable compatibility with anionic surfactants

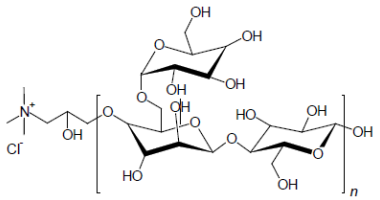
- Methyl Chloride



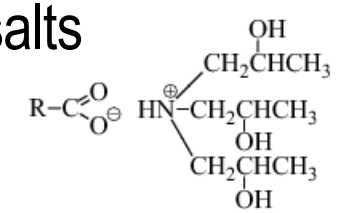
- Methyl Sulfate



- Hydroxypropyl

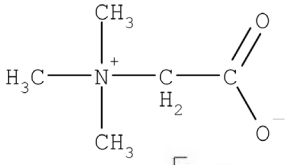
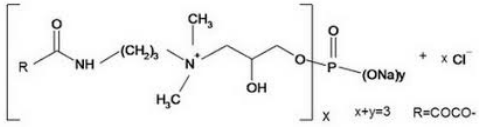
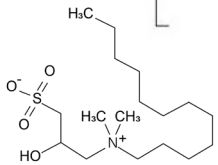
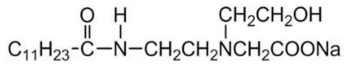
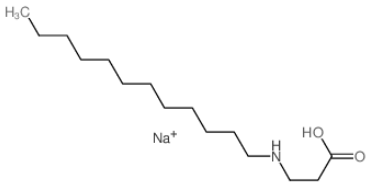


- Amine salts



Types of Surfactants

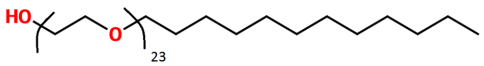
- Amphoteric/Zwitterionic ±
  - Viscosity, foam enhancement
  - Reduce irritation of anionic surfactants
  - Amphoteric vs zwitterionic

- Betaine 
- Phosphobetaine 
- Sultaine 
- Amphoacetate 
- Propionate 

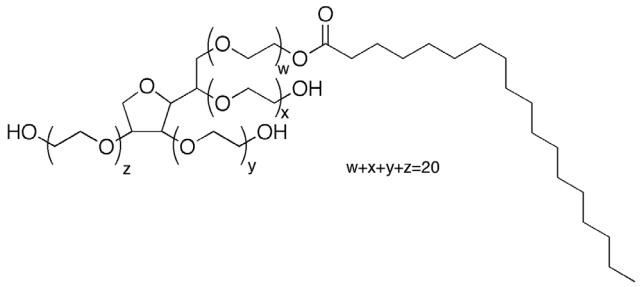
Types of Surfactants

- Nonionic
  - Huge variety of chemistry
  - Include ethoxylates
  - Low irritation potential

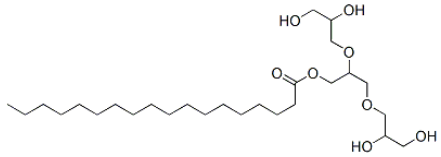
- Alcohol ethoxylates



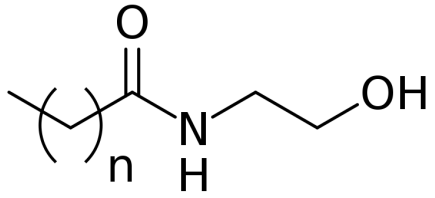
- PEG esters



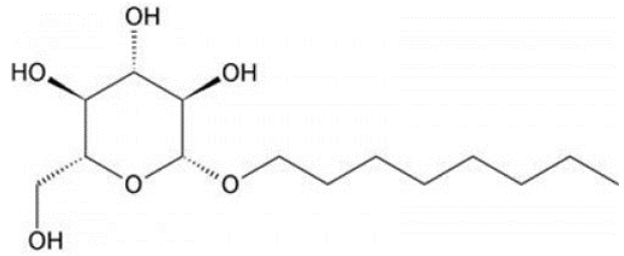
- Polyglyceryl esters



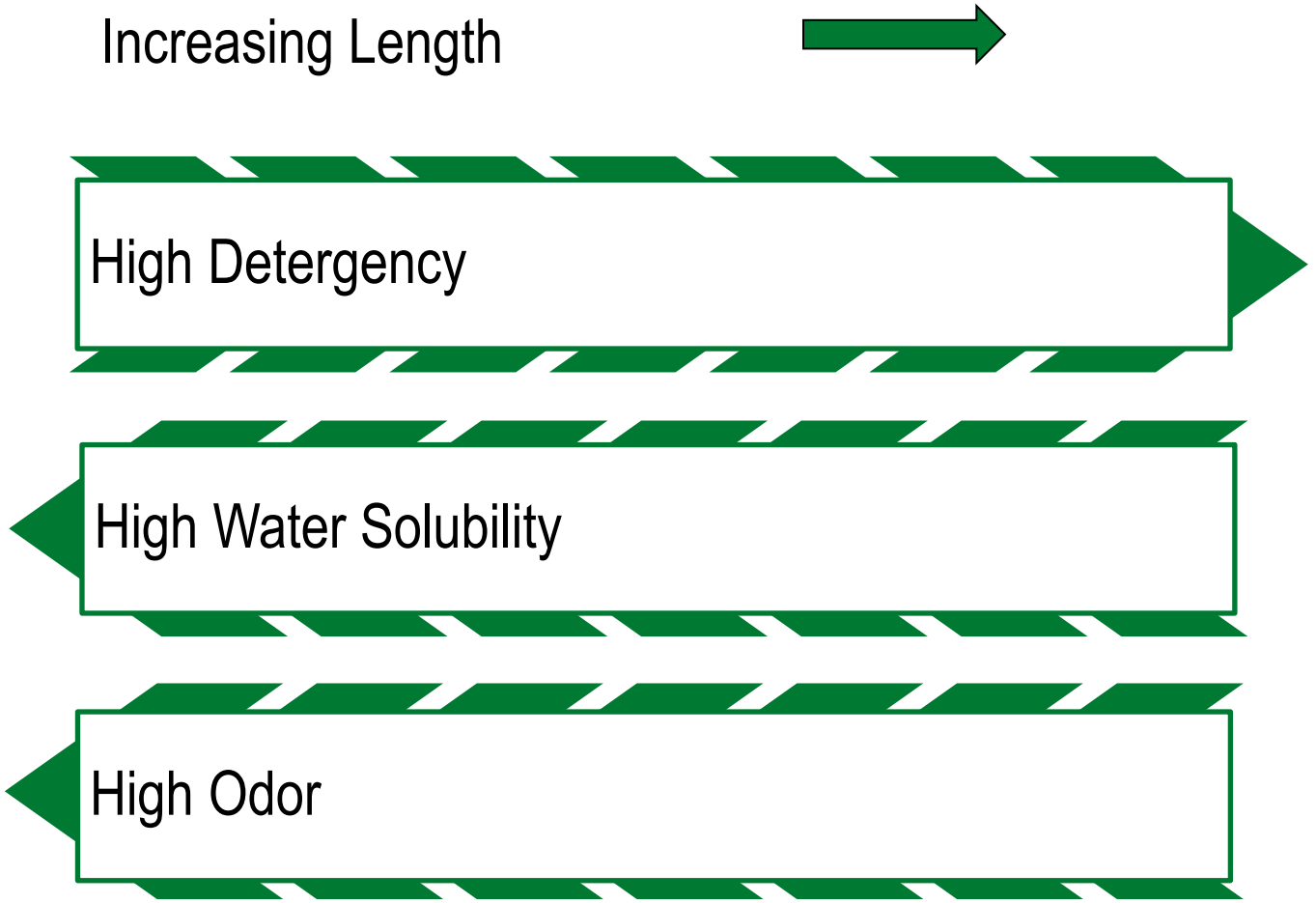
- Alkanolamides



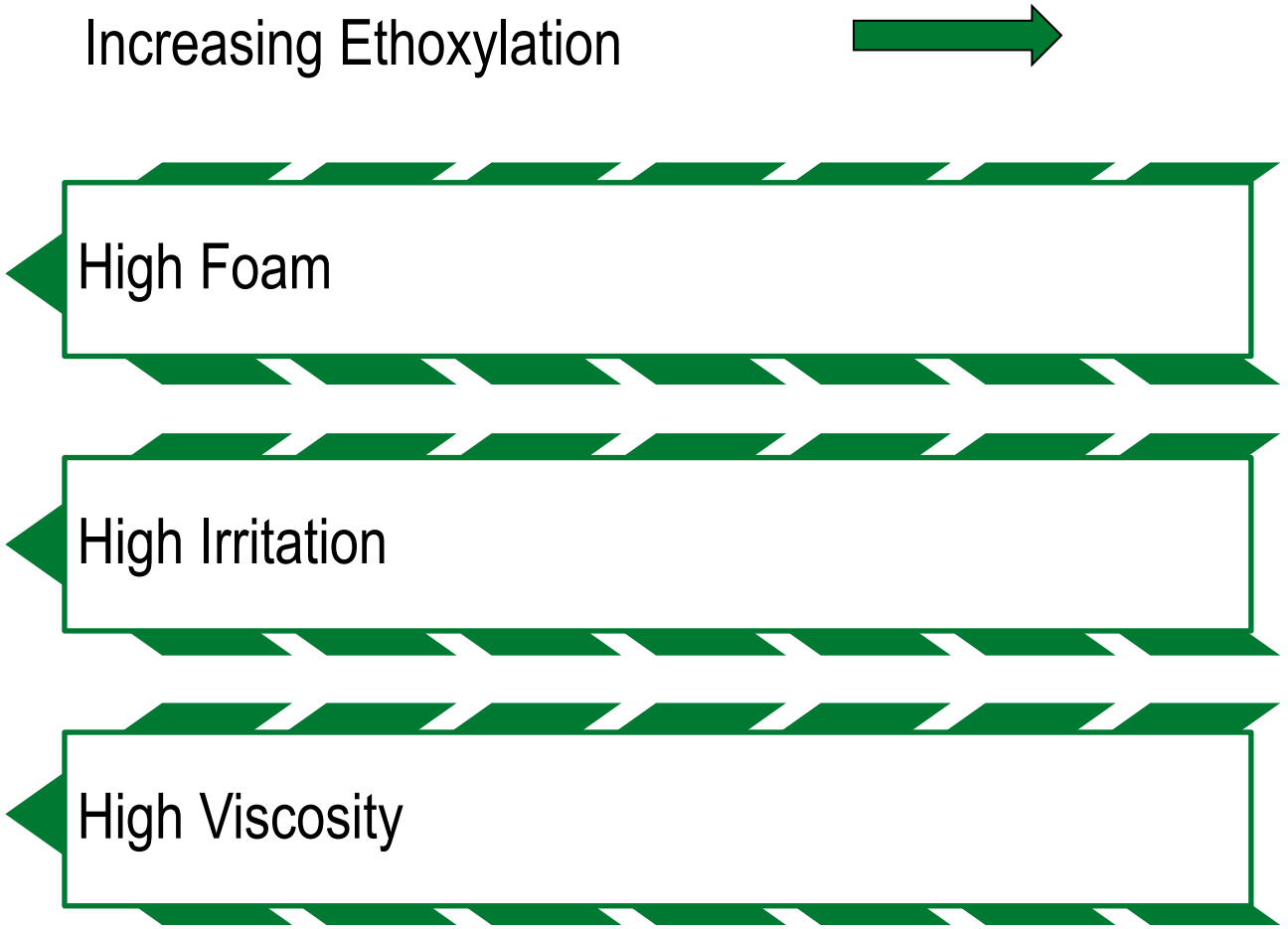
- Glucosides



Chain Length



Ethoxylation



Future of surfactants?

- Biosurfactants
  - Microorganisms convert carbon sources to a variety of surfactant molecules
    - Glycolipids
    - Rhamnolipids
    - Sophorolipids
    - Sphingolipids
  - Carbon can come from wide variety of sources
    - Traditional triglyceride oils, including waste oils
    - Sugars, starches, carbohydrates
    - Hydrocarbons
  - Currently limited by low yield

Going Sulfate-Free

- There are many challenges associated with moving from traditional anionic surfactants to next generation products
  - Different foam properties
  - Different functional groups
  - Different packing capabilities
  - Different salt responsiveness

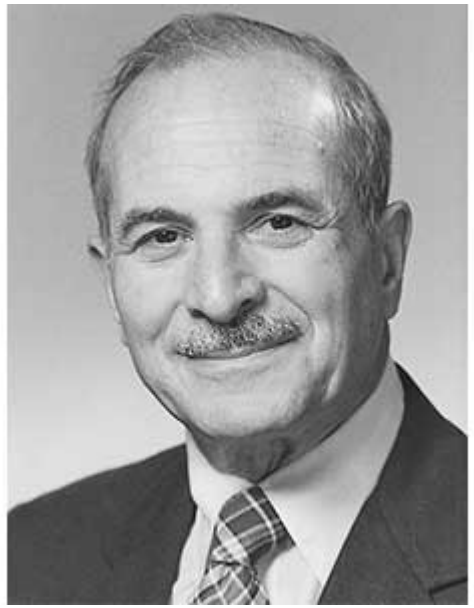
- Strategies for evaluating sulfate-free surfactants

In Remembrance

- Milton J Rosen
- February 11, 1920 – February 2, 2020

- Over 150 patents and publications
  - Structure/function relationships of surfactants
  - Equations for surfactant synergism
  - Gemini surfactants

- *Surfactants and Interfacial Phenomena*



Additional Resources

- SCC Media Library & Resource Center
  - https://library.scconline.org/

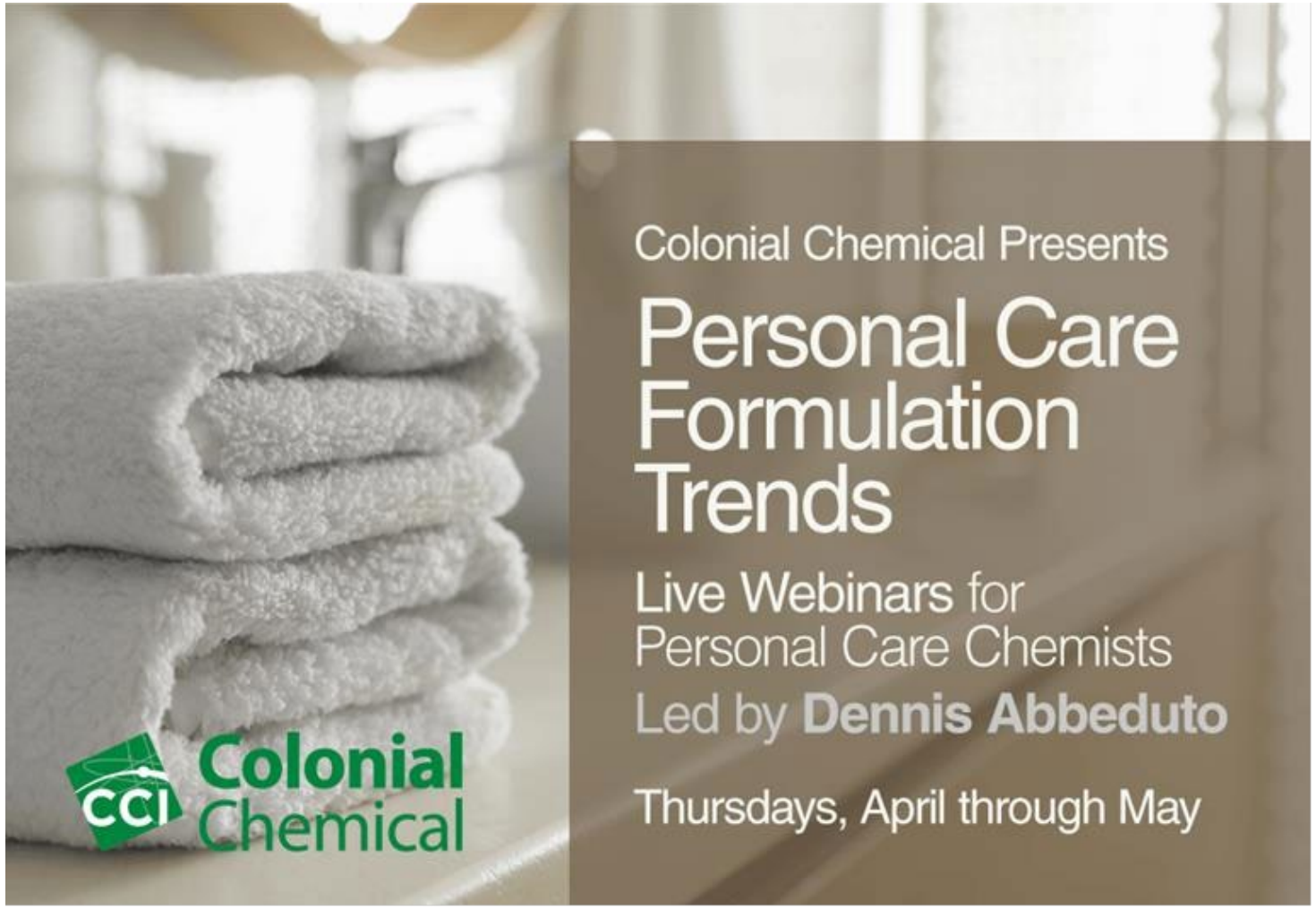
- Scientific Spectator
  - http://www.scientificspectator.com/book-service/
  - Surfactants: Strategic Personal Care Ingredients and Supplement

- Dr Steven Abbot's "Surfactant Science: Principles and Practice"

Webinar Series

- May 7 – Salt-free Surfactants
- May 14 – Alternate Preservation
- May 21 – Dioxane-Free Formulas
- May 28 – Sulfate-Free Formulas

- **https://bit.ly/2XXTbEO**



Thank you!

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