<u>Project 4</u>: Interaction between skin stratum corneum and personal care products

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<u>Project Summary</u>

After using cleansers or dish washers which contain surfactants and other chemicals, our skin 'feels' dehydrated (or hydrated), or rough (or smooth).[3] The **<u>big idea</u>** of this project is to fill a gap in knowledge of how chemicals from personal care product interact with stratum corneum, the outermost skin layer, at the molecular level. Stratum corneum (SC) consists of corneocytes and lipid bilayers in a 'brick and mortar' structure configuration (Figure 1).[1-3] The lipid bilayers in human SC consists of ceramides, fatty acids and cholesterol, which are important elements of the skin barrier.[4] It is known that the lipid bilayers provide a hydrophobic barrier to prevent transepidermal water loss (TEWL).[5-6] Corneocytes are keratinocytes without nuclei and cytoplasmic organelles. Major constituents of corneocytes are keratin intermediate filaments organized in parallel bundles to form a matrix to give rigidity to the overall structure of the skin and to protect our body from external environmental conditions such as UV irradiation.[2]

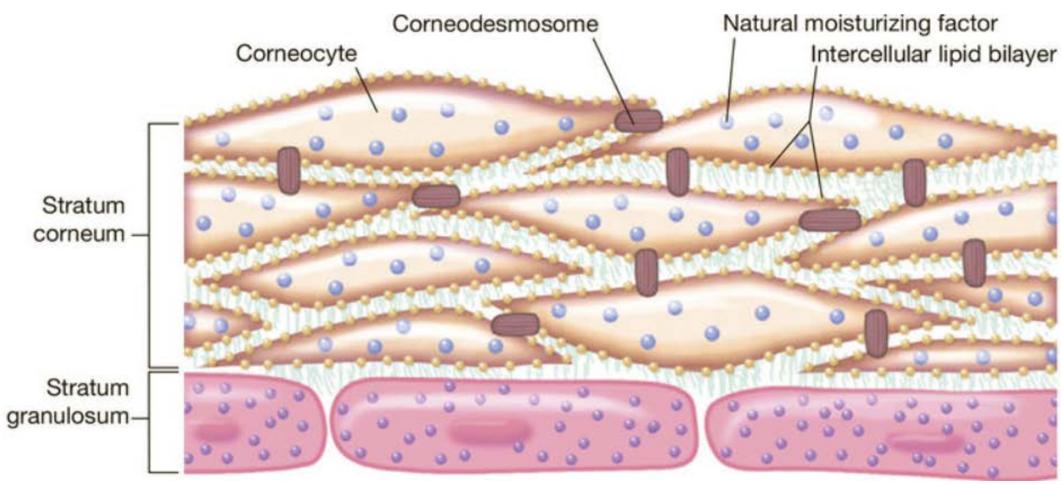

Figure 1. Stratum corneum consists of corneocytes and lipid bilayers in a 'brick and mortar' structure configuration.

Investigation of dehydration or skin resilience is clinically important because skin disorders such as atopic dermatitis are affected by personal care products. It has been a **challenge** to decouple the effect of keratin and the lipid bilayer on dehydration rate for the short-term and long-term in vivo or ex vivo. In addition, in vivo or ex vivo examination is not ideal to investigate the mechanism at the molecular level because of skin-to-skin variation and technical limitation.

Our lab has recently developed a stratum corneum substitute (SCS) model to understand the fundamentals of how surfactant is interacting with lipid or keratin (Figure 2). The research topic is inspired by Proctor and Gamble (P&G) and has a potential collaboration opportunity with P&G. Our preliminary data with Proctor & Gamble (P&G) demonstrate that our SCS model has the same characteristics as an actual human SC in wide angle x-ray scattering and small angle x-ray scattering data, indicating the lateral and lamellar packing is similar to the humans.

The ***guiding questions*** for the research are: 1) what is the underlying mechanism in surfactant SC at the molecular level? 2) how does this inform macroscale behaviors such as hydration and roughness? and 3) is there a useful correlation that allows the skin model to be used to develop formulations safe for skin?

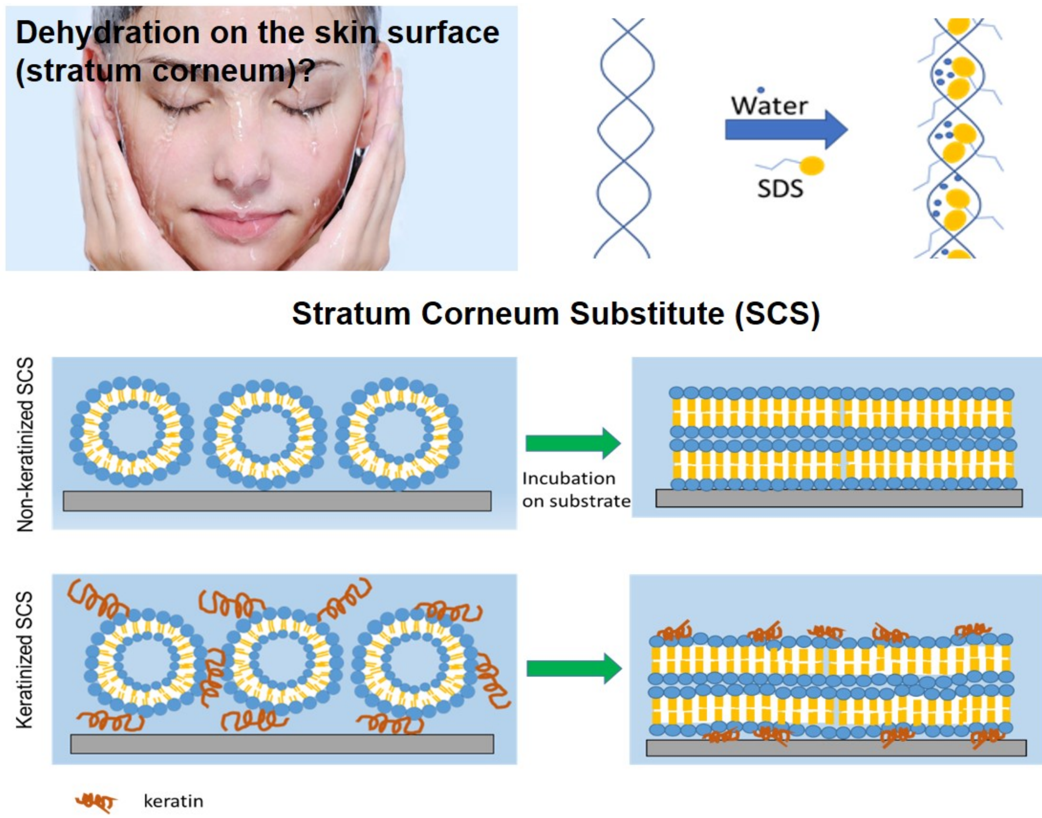

Figure 2.Schematics of stratum corneum substitute fabrication and molecular interaction of surfactant with keratin in stratum corneum.

Tasks:

Teachers will determine dehydration rate for short term and long term with the SCS model using various chemicals in personal care products. They will also investigate the interaction at the molecular level using contact angel measurement and Fourier Transform-Infrared spectrometer (FT-IR). The following is the specific tasks that the teachers will perform:

1. Measure dehydration rate using microbalance when various chemicals are added.
2. Determine interplay between molecular level dynamics and macroscale property changes via contact angle measurement and FT-IR.

Research Facilities:

The research will be conducted primarily in the Park laboratory at the University of Cincinnati.

- SCS synthesis, SCE characterization, and measurement of dehydration rate will be performed in Park laboratory, 583 ERC.
- FT-IR is in Core Facility of Chemistry, 102 Crosley.
- Equipment for contact angle measurement and particle size characterization is in 609 Rhodes Hall.

Ideas for Classroom Implementation

Throughout the project, teachers will be introduced to and gain knowledge into the emerging field of skin science and engineering, and in turn be able to expose students to the basic concepts of chemistry and chemical engineering. Teachers will be able to learn how to propose hypotheses and apply to classroom and teach students how to perform hypothesis-driven research.

Teachers will be able to integrate the following concepts to the classrooms:

- **Middle school (Grades 6-8):** What is hydrophilic and hydrophobic? What does a contact angle at interface mean?
- **High School (Grades 9-12):** What is surfactant? How can you change the contact angle? How does surfactant work at the surface?
- **College (Grades 13-14):** How does surfactant interact with protein or lipid? Does this depend on a kind of surfactant (anionic, cationic, nonionic, zwitterionic)?

References

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