In vitro characterization of skin-microbiome interactions

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Human skin spans an average of 20 ft^2, offering a large habitat for the diversity of microbes that constitute the skin microbiome,[1] with conditions that vary in moisture levels, sebum content, acidity, temperature, and environmental exposures. Interactions between skin microbes and the human host have a number of important health implications. Microbes impact the rate of wound healing.[2] They influence barrier function of the skin, bearing relevance to protection against environmental exposures, physical invasion, and infection.[3] In addition, they affect the host's attractiveness to arthropods, which subsequently could play a role in vector-borne disease transmission.[4]

While the skin microbiome is known to play several important roles, there is little understanding of the precise causal interactions. Interactions occur on several axes – between the host and microbes (host-microbe), between the microbes themselves (microbe-microbe), and between the microbes and the environment (microbe-environment). In vitro experiments offer a powerful approach for cutting through this complexity. In particular, recent research by Loomis et al. has revealed that skin microbes can impact epidermal thickness, host cell proliferation, and barrier function. Unique effects were observed for a mixed community of microbes, compared to the effects of individual microbes.[5] However, the mechanisms underlying these observed impacts remain to be determined.

We aim to probe the mechanisms though which microbes and microbial communities impact host skin processes. Specifically, we focus on culturing human keratinocytes with eight abundant and prevalent species of skin microbes. A single layer of keratinocytes is cultured in wells before adding bacteria in a liquid solution on top of the cells. The bacteria and human cells are allowed to grow in the combined culture for 18 hours before the cells are removed for analysis. The complete analysis will include viability, metabolomics, and transcriptomics, focusing on the bacterial transcriptome.

Initial results on cell viability are promising and show that almost all the bacteria species still multiply significantly in the presence of keratinocytes. Most of the keratinocytes also maintain viability during co-culture. These initial viability results further support the idea that the analysis of this experiment may lead to a better understanding of the mechanisms between the microbiome and skin. Ultimately, the resulting mechanistic knowledge may help to guide strategies for optimizing skin health.

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[1] Grice and Segre, "The Skin Microbiome."
[2] Monroe, "Looking for Chinks in the Armor of Bacterial Biofilms."
[3] Jensen and Proksch, "The Skin's Barrier"; Borkowski and Gallo, "The Coordinated Response of the Physical and Antimicrobial Peptide Barriers of the Skin."
[4] Verhulst, Boulanger, and Spitzen, "Chapter 3 - Impact of Skin Microbiome on Attractiveness to Arthropod Vectors and Pathogen Transmission."
[5] Loomis et al., "A Mixed Community of Skin Microbiome Representatives Influences Cutaneous Processes More than Individual Members."