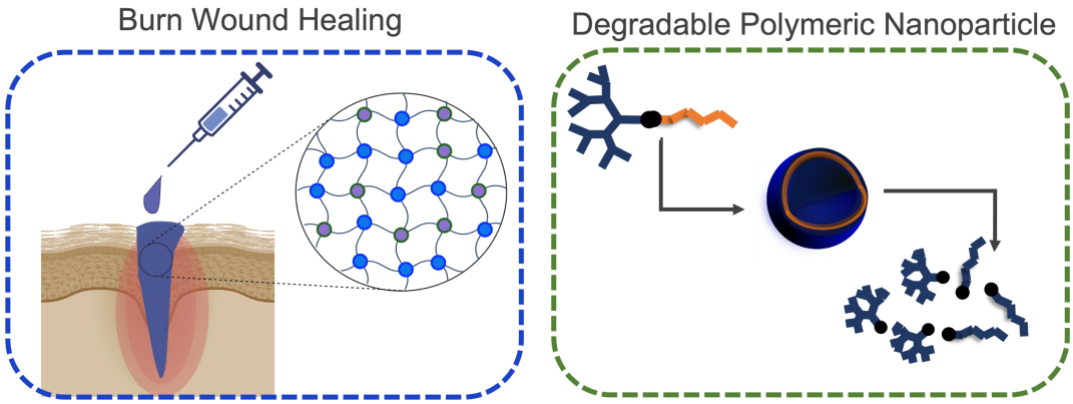
Simms Lab of Functional Biomaterials

Overview: Research in the Simms Lab of Functional Biomaterials focuses on the strategic design of bio-interactive materials that directly addresses health equity concerns from a chemistry and biomedical engineering perspective. Currently, we are developing polymeric biomaterials for applications in wound healing and therapeutic delivery. If you have special interests in conducting interdisciplinary research that bridges synthetic organic chemistry, biochemistry, and biomedical engineering in a dynamic learning environment, this might be the lab for you! For more information regarding the current research in our lab or becoming a lab member feel free to contact Dr. Simms at: simmsbl.ucmail.uc.edu.



Project 1:

According to the American Burn Association, 11 million burns (of all types) occur annually. Unfortunately burn injuries are more prevalent in vulnerable communities (considering socioeconomic status, disabilities, and the elderly). Current methods of treating burn wounds include skin grafting (requiring healthy skin with an immune match) or polymeric dermal substitutes (which often lack the dermal components to encourage tissue regrowth). We believe that injectable, polymeric hydrogels are the solution to promoting burn wound healing and tissue regeneration. With these things in mind, we aim to design and develop a hydrogel scaffold for applications in burn wound healing.

Burn wounds are classified by the depth of penetration within the skin caused by extreme heat, electrical, or chemical means. One of the reasons that tissue engineering has become a rapidly growing field is to close the gap between the supply and demand for tissue and organ transplantation. As it pertains to skin, tissue engineering aims to assist the physiological healing of epithelium and induce the regeneration of skin and its components. The development of hydrogels for use as tissue engineering scaffolds has proven to be a useful strategy for promoting the growth and formation of the desired tissue after a burn. The specific challenges we will address are 1) developing a library of injectable hydrogel scaffolds with varying physical and mechanical properties that match that of various skin types, and can be injected into irregular shaped wounds, 2) develop a scaffold that allows for the delivery of therapeutic agents and cell infiltration for tissue regeneration, and 3) address differences in skin pigmentation by encouraging melanogenesis (formation of melanin) within the skin.

Project 2:
There are lots of health-related challenges that can result in someone taking a significant amount of pills/medications over a prolonged period of time. What if there was a way that all of the medication for a given time period was administered simultaneously in one simply injection? This is the premise of another project area in the Simms Lab of Functional Biomaterials.

Polymeric nanoparticles are a favorable vehicle for the delivery of therapeutics. Although some polymeric materials have made their way to clinical settings, there is still significant room for improvement in the realm of overall stability, drug loading capabilities, targeted delivery, and drug release. To this end, our lab will be designing, and synthesizing Janus-type dendrimer-based amphiphiles that can self-assemble into nanosized-carriers. The specific challenges we will address are 1) design a library of fully degradable nanoparticles, 2) integrate a timed-release system into established particle systems 3) introduce specified targeting moieties to understand targeting pathways.

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