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Harnessing Bioprinting Technology To Develop More Customizable And Physiologically Relevant Skin Models Against Vesicant Exposure

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Bioprinting has emerged as a promising technology in the microphysiological systems realm by combining traditional 3D printing techniques with biological components. These novel advancements yield the potential for developing customizable organ models with selection of cell type, biomaterials, and additives. The use of computer aided design allows the user to make intricate designs and model micro architecture, similar to what is found in the body.

The skin is the body's largest organ and its first line of defense to chemical and biological threats. This project utilized multiple types of bioprinters to develop bioprinted skin models as microphysiological systems. The skin models incorporated primary human dermal fibroblasts and kertainocytes, which were used to represent the dermis and epidermis layers of the skin. Research and development was focused on optimizing the bioinks used for the skin model and bioprinting parameters (i.e. pressure, temperature, nozzles).

Vesicants are blistering agents that have been used historically in chemical warfare. Sulfur mustard (HD) was used to test and validate the bioprinted skin models as there is vast data in various animal models and 2D and 3D in vitro models at the U.S. Army DEVCOM Chemical Biological Center (DEVCOM CBC). Live-dead assays, among other downstream analysis methods, were used to assess the bioprinted skin in comparison to existing skin models. After successful preliminary results with bioprinting skin, future avenues include incorporating more complexity, such as immune cells and melanin, into the skin model.

Bioprinting multiple layers of cells allows a more relevant model to the skin, as the skin is composed of multiple layers. Through this technology, we can see cell-cell interactions in a 3D format. Bioprinting enables further complexity into 3D in vitro models and can contributing a cutting-edge to the microphysiological systems field that DTRA JSTO has invested in. By harnessing this technology in-house, DEVCOM CBC can better model and assess existing and emerging threats to the warfighter.

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