

# BIOENGINEERING

PRESENTS

## Bio-inspired Technologies for Applications in Hemostasis, Thrombosis and Thromboinflammation



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2101 ENGINEERING V

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### ABSTRACT:

Platelet transfusions are clinically used in prophylactic management of bleeding risks in thrombocytopenic patients, as well as emergency management of bleeding in trauma and surgeries. However, natural platelet products suffer from challenges of (i) limited availability and portability, (ii) pathogenic contamination risks resulting in very short shelf-life (~5 days), and (iii) various biological side-effects. Current pathogen reduction technologies and recent research with temperature reduced (chilled, freeze-dried etc.) platelets have extended the shelf-life to a few weeks, but have not fully resolved the issues of widespread availability both within and outside of hospitals (e.g. at point-of-injury), and the issues of variable hemostatic performance in vivo. In this framework, our research is focused on developing nanoparticle-based technologies that mimic and amplify platelet-mediated mechanisms of hemostasis, by modular mimicry of injury-site targeted adhesion and aggregation, coagulation amplification and secretion of hemostasis-augmenting molecules. These technologies can potentially allow large scale manufacture, reproducible quality control, storage over months-to-years, and efficient hemostatic management of patients in both prophylactic and emergency settings, when natural platelet products are unavailable or in limited supply. We have evaluated these technologies for hemostatic performance in vitro and in vivo with promising results, and are currently advancing them through academic research as well as through a biotech start-up I co-founded (Haima Therapeutics), towards clinical translation. Furthermore, these bio-inspired systems can be modularly refined or engineered to act as 'targeted drug delivery' vehicles for site-specific therapy in pathologies where platelets are majorly involved, e.g. in thrombosis and thromboinflammation. To this end, we have engineered platelet-inspired systems that enable targeted fibrinolysis (clot breaking), for potential application in thrombolytic therapies. We have also engineered drug delivery systems that target 'platelet-neutrophil complexes' for potential application in sterile thrombo-inflammatory diseases, and have carried out pilot studies with them in vitro and in vivo. We continue to develop these technologies with a vision for potential applications in treating deep vein thrombosis, chronic wounds and cancer where platelet- and neutrophil-mediated processes become unique mechanistic drivers of disease pathology. In parallel to such therapeutic technologies, we also work collaboratively in developing portable hand-held diagnostic devices for point-of-care/field use in detecting coagulopathies, e.g. using dielectric coagulometry. Thus, our research is at the interface of biology, chemistry, engineering and medicine, to create bioinspired technologies directed at efficiently addressing and resolving clinical challenges in hemostasis, thrombosis and thromboinflammation.