2025/6/5

Bio-inspired Technology: Research, Development, and Commercialization

『 Zwitterionic Membranes and Biomedical Applications 』

Yung Chang
R&D Center for Membrane Technology and Department of Chemical Engineering, Chung Yuan Christian University, Taiwan
E-mail: ychang@cycu.edu.tw

Zwitterionic membranes represent a cutting-edge advancement in nonfouling separation technologies, surpassing conventional poly(ethylene glycol)-based systems through superior hydration and biofouling resistance. In this presentation, I will highlight our laboratory's recent progress in the molecular design, fabrication, and functionalization of bio-inspired zwitterionic membranes, tailored for advanced medical applications. We have developed a series of zwitterionic polymers and copolymers—including sulfobetaine, carboxybetaine, and phosphobetaine derivatives—with well-defined architectures to achieve optimal interfacial control and membrane performance. These materials have been successfully applied to membrane surfaces through coating, surface grafting, and in situ modification, enabling high-efficiency selective separation in biomedical contexts.

The core of this presentation will focus on three key applications of zwitterionic membrane separation technologies in human health: (1) Disease Prevention – Application of membranes in leukocyte depletion to enhance transfusion safety by selectively removing white blood cells from donor blood products; (2) Disease Diagnosis – Integration of zwitterionic membranes in biosensing platforms for rapid and specific sepsis biomarker detection, enabling early disease diagnosis; (3) Disease Treatment – Utilisation of membrane-based cell separation and purification technologies in cell therapy, particularly for isolating and activating natural killer (NK) cells used in cancer immunotherapy.

In this presentation, I will outline emerging trends in membrane science, emphasizing the pivotal role of zwitterionic membrane separation technologies in transforming medical diagnostics, therapeutic interventions, and patient outcomes. The continued innovation in zwitterionic membrane design and functionalization will be critical in advancing precision medicine and next-generation healthcare solutions.

References

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