Coating of implantable scaffolds with red blood cell membranes to tune microbial response

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INTRODUCTION

Cell membranes are emerging as valuable tools for modulating scaffold–cell interactions in tissue engineering. Beyond acting as protective barriers, they mediate **biochemica**l signaling that regulates **cell growth**, **differentiation** and **immune responses**. While cell membrane-coated nanoparticles are widely used in nanomedicine, such as tumor cell membranes for homotypic targeting or red blood cell (RBC) membranes for immune evasion, their application in 3D scaffolds remains far less explored. Such coatings offer a promising bioinspired interface that may enhance and sustain tissue regeneration [1]. However, progress in this field is challenged by the need for reproducible isolation and preservation of functional membrane components, and scalable production under good manufacturing practices. Among potential membrane sources, blood represents one of the most practical options, offering a consistent and widely available supply of cellular membranes. This work aims to evaluate the **potential of RBC membrane-coated PLA scaffolds** to modulate bacterial adhesion and enhance **infection resistance** in **tissue engineering** applications.

METHODOLOGY & RESULTS

1 PLA SCAFFOLD FABRICATION

PLA scaffolds were fabricated using fused deposition modelling (FDM) technique.

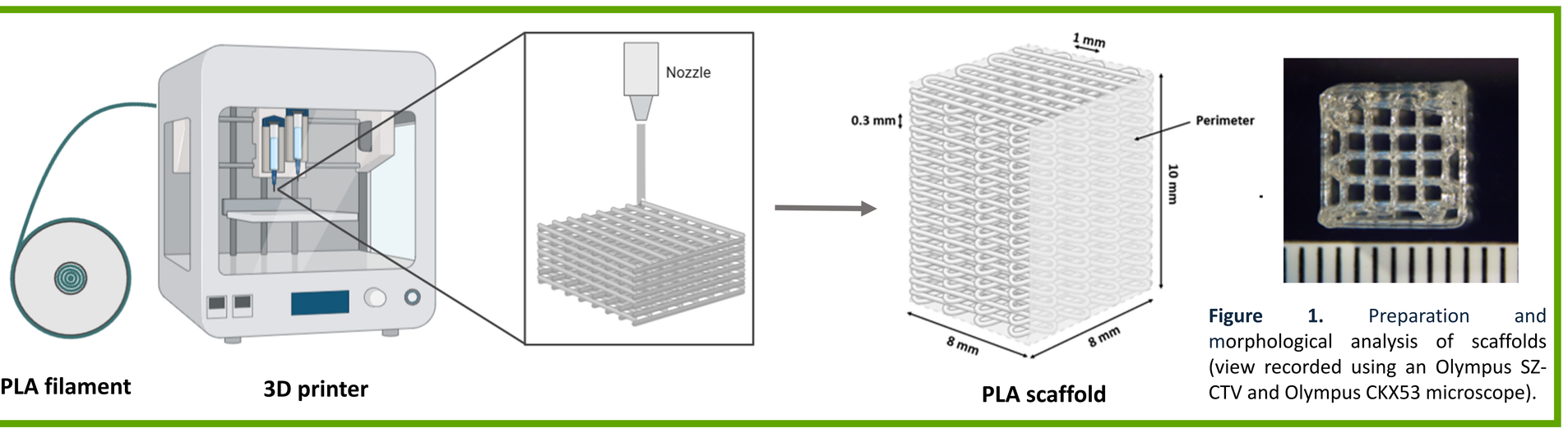
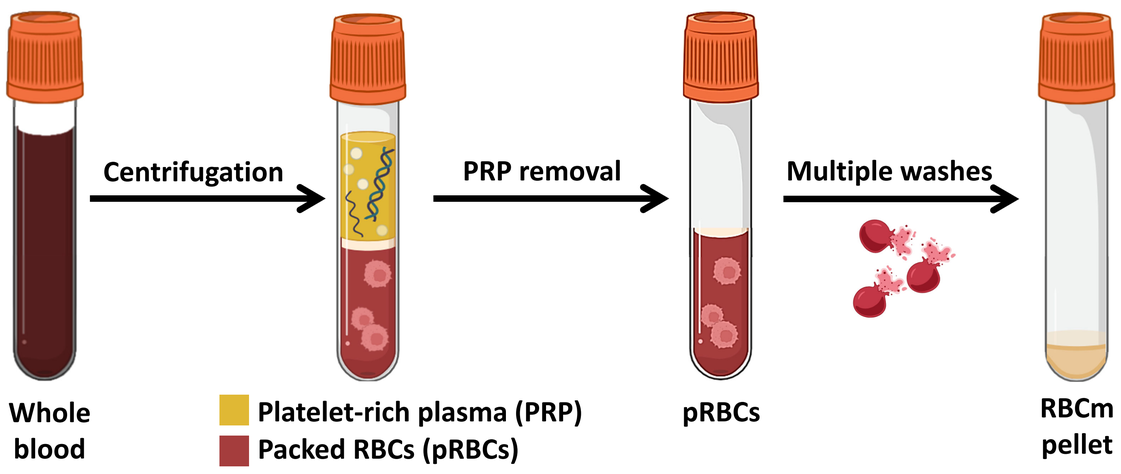


Figure 1. Preparation and morphological analysis of scaffolds (view recorded using an Olympus SZ-CTV and Olympus CKX53 microscope).

2 RBC MEMBRANE ISOLATION

RBC membranes (RBCm) were isolated from healthy donors under ethical approval, via hypotonic lysis of erythrocytes.



3 SCAFFOLD COATING

Sterile PLA scaffolds were incubated in an RBCm suspension (1 mL, 250 µg/mL). Membranes were labeled with DiO (25 µL) prior to incubation, and coating was confirmed by confocal fluorescence microscopy.

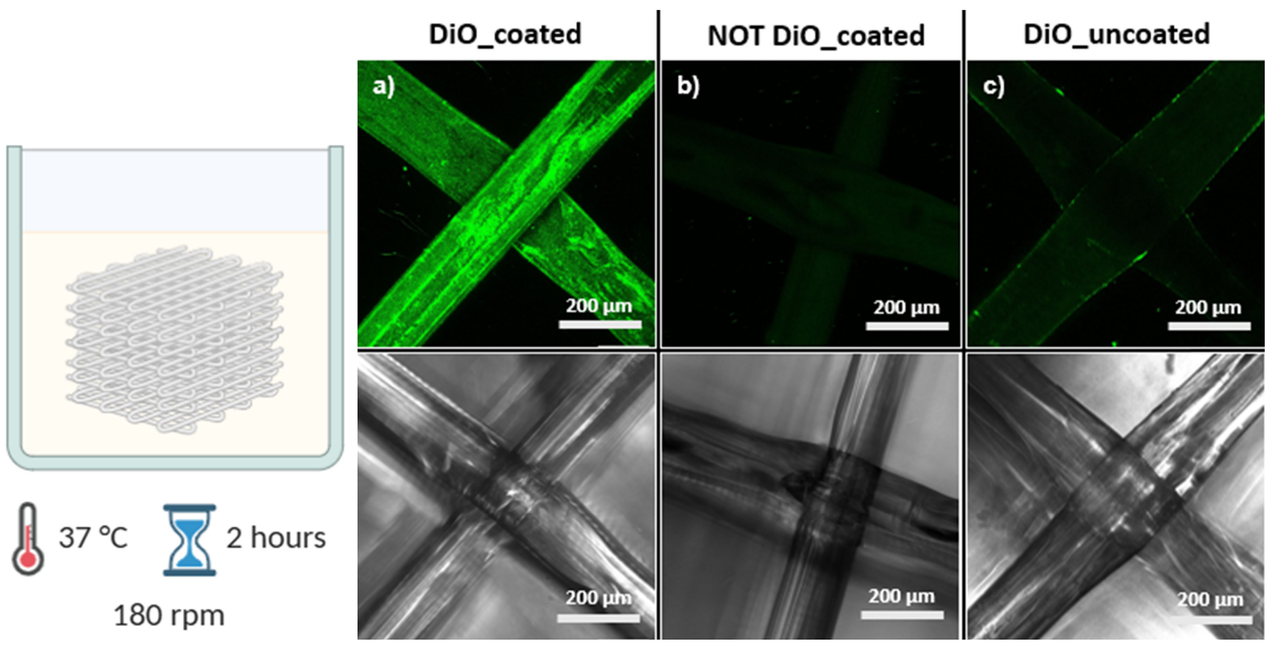


Figure 2. Confocal microscopy imaging of PLA scaffolds. a) Scaffolds with DiO-stained membranes (green signal). b) Negative control without DiO-stained membranes. c) Negative control with DiO. Scale bar 200 µm.

4 BACTERIAL ADHESION

The ability of the scaffolds to inhibit bacterial colonization was assessed against *S. aureus* and *P. aeruginosa* in TSC medium. Biofilm viability was evaluated using an MTT assay and CFU counting [2].

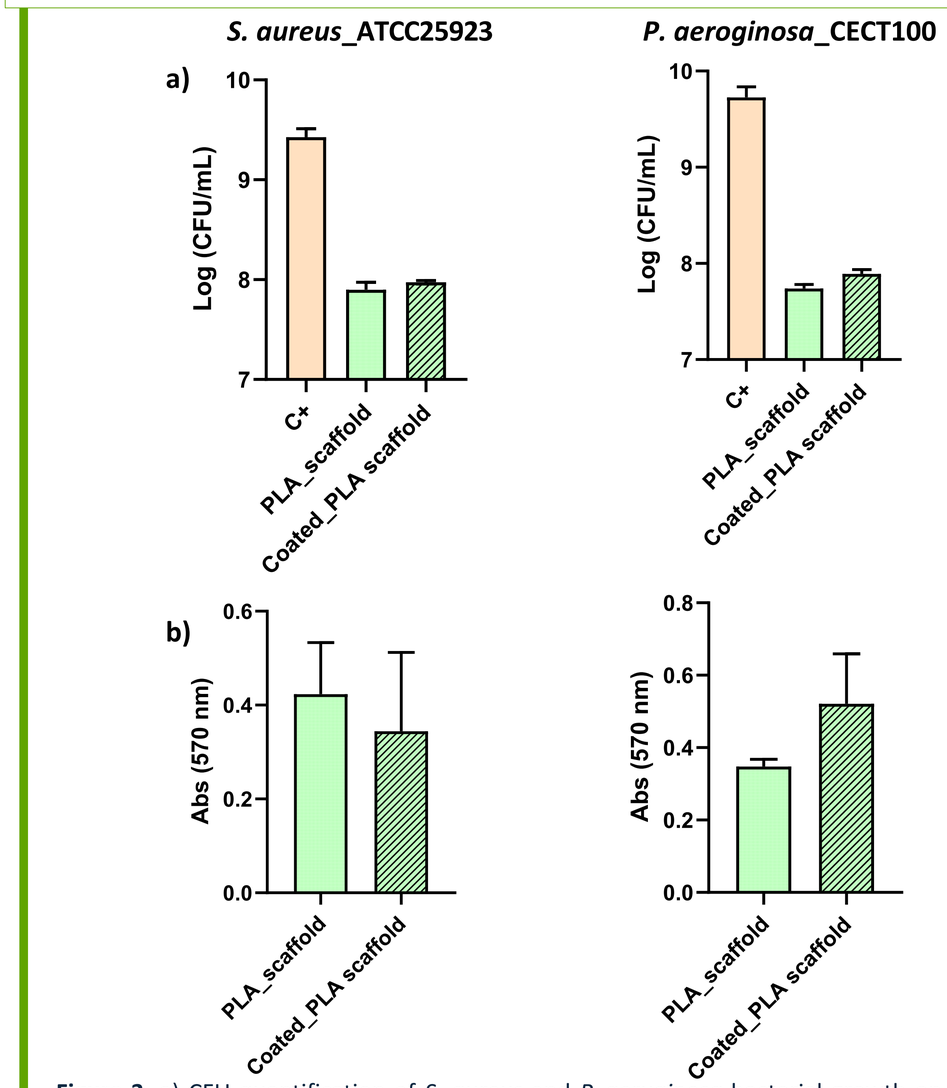


Figure 3. a) CFU quantification of *S. aureus* and *P. aeruginosa* bacterial growth on coated and uncoated scaffolds after 24 h and 12 h of incubation, respectively (n=3); b) MTT-based metabolic activity of *S. aureus* and *P. aeruginosa* on coated and uncoated scaffolds (n=3).

CONCLUSION

Red blood cell membrane coatings on 3D printed PLA scaffolds were successfully obtained and confirmed by confocal microscopy. Further optimization of the coating strategy is underway to improve antibacterial performance.

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[2] Farto-Vaamonde et al., *Journal Controlled Release*, 352, 776-792 (2022).