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Antimicrobial and Anti-Inflammatory Gallium Implanted 'Trojan Horse' Surfaces for Implantable Devices

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A rapidly aging population, high incidence of osteoporosis and trauma-related fractures, and better health care access explain rapid surge in utilisation of orthopedic implantable devices. Unfortunately, many implants fail without strategies that synergistically prevent infections and enhance the implant's integration with host tissues. Here, we propose a solution that builds on our pioneering work on gallium (Ga)-enhanced biomaterials, which show exceptional antimicrobial activity, and combined it with defensin (De, hBD-1), which has potent anti-microbial activity in vivo as part of the innate immune system. Our aim was to simultaneously impart antimicrobial activity and anti-inflammatory properties to polymer-based implantable devices through the modification of the surfaces with Ga ions and immobilisation of De. Poly-lactic acid (PLA) films were modified using Ga implantation using the Surface Engineering Beamline of the 6MV SIRIUS tandem accelerator at ANSTO Australia, and subsequently functionalised with De. Ga ion implantation increased surface roughness and increased stiffness of treated PLA surfaces and led to the reduction in foreign body giant cell formation and expression of pro-inflammatory cytokine IL-1 β . Ga implantation and defensin immobilization both independently and synergistically introduced antimicrobial activity to the surfaces, significantly reducing total live biomass. We demonstrated, for the first time, that antimicrobial effects of De were enhanced by its surface immobilization. Cumulatively, the Ga-De surfaces were able to kill bacteria and reduce inflammation in comparison to the untreated control. These innovative surfaces have the potential to prevent biofilm formation without inducing cellular toxicity or inflammation, which is essential in enhancing integration of implantable devices with host tissues and hence, ensure their longevity.

Level of Expertise

Student

Presenter Gender

Woman

Pronouns

She/Her

Which facility did you use for your research

Centre for Accelerator Science

Students Only - Are you interested in AINSE student funding

Yes

Do you wish to take part in the Student Poster Slam

No

Condition of submission

Yes

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