

Challenge based learning (CBL)

Microfabrication of an anti-thrombotic surface topography on stents

Note for teachers: A CBL user guide can be found at www.jandeboerlab.com/TissueEngineering with instructions and tips to run an effective CBL teaching session.

Background and vision

Biomaterials are employed in the manufacturing of medical implants and as scaffolding materials in tissue engineering and regenerative medicine. Human cells and tissues frequently elicit an unwanted response, such as encapsulation, implant loosening or stress shielding which can lead to implant failure. Micropatterning at the nanometer and micrometer range has been used in this field to influence cell-material response and it is the long-term vision to engineer custom-designed biomaterial topographies onto medical implants to manipulate cell response for an optimal function.

Motivation and stakeholders

Patients with occluded blood vessels are treated with implanted stents which restore the blood flow. A disadvantage of stents is that their materials induce blood clotting. As a consequence, patients with stents need to use blood-thinning medicine their whole life, which bears risks and is costly. Solutions to mitigate this problem should consider the needs, requirements and regulatory, financial and technical boundary conditions defined by stakeholders such as cardiovascular surgeons, biomaterial engineers and entrepreneurs who have to implement new stent technology in cost-effective products.

Problem definition

Currently, photolithography is a 2D technique, whereas a stent is a 3D structure. Assuming that future biomaterial screening efforts will lead to the identification of topographies that induce reendothelialization, this still leaves the question on how to put them on a stent. Therefore, there is a clinical need to generate microfabrication strategies that introduce nano- and micro-topographies in anti-clotting stents.

Challenge

To design a microfabrication technology that could introduce anti-coagulant topographies in the stents currently used in the market.

Learning framework

Reading the Microfabrication Technologies and Cardiovascular Tissue Engineering chapter will help you to understand:

1. The clinical implication of atherosclerosis.
2. The mechanisms of plaque build-up in blood vessels
3. The current treatment strategies for occluded blood vessels
4. The ways biomaterials induce coagulation and the pharmacological interventions to resolve clots in blood vessels.

For a more focused examination of the challenge, read scientific literature and create a mind map to include information about the following:

5. Current strategies to manufacture topographies on 2D surfaces.
6. The state-of-the-art of to produce topographies on 3D surfaces.
7. The current strategies to induce reendothelialization in stents.

End product

A three-minute video explaining the solution of your challenge. Please include your motivation and the steps to execute your solution.

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