A promising biointerface for endothelial cells assembled from mixed poly(dopamine) film

When implants are put into a patient's body, there will be contact between this material and the surrounding tissue. Successful implantation requires that the body integrates the foreign materials. The surface of implants plays an important role in this context. Coating implants with a polymer films can mediate the interaction of foreign materials with biological tissues through the so-called biointerface. The ideal biointerface induces desired cell responses. Many factors such as chemical composition, softness, topography, or the presence of adhesive patches in the polymer film can have great influence on the success of a biointerface.

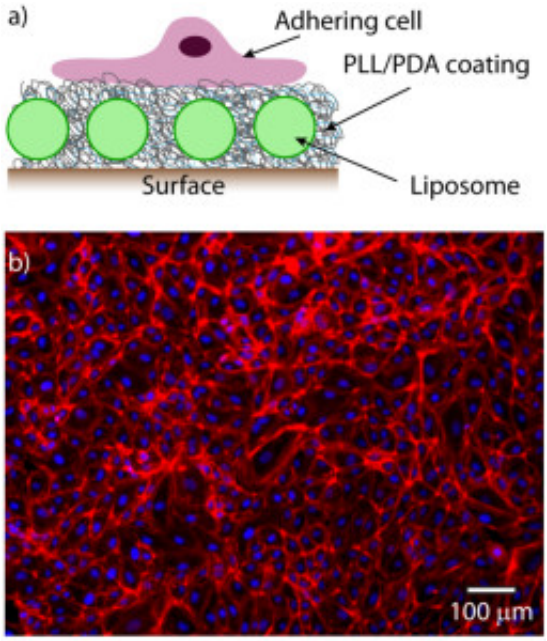

Fig. 1. a) Schematic illustration of the assembled film including an adhering cell. The film consists of PLL/PDA with embedded liposomes. b) Fluorescent microscopy image showing cells grown on such a polymer film. The nuclei of the cell is shown in blue and the actin filaments are shown in red. The actin filaments of a cell are essentially the skeleton of a cell so that it can keep and change its shape.

A polymer film made of poly(dopamine) (PDA) is a very good example in this context. PDA films are formed on a large variety of different surfaces when dopamine is dissolved at slightly basic conditions. Under these conditions, the material which should be coated has simply to be submerged in this dopamine solution, and the coating is deposited by itself. The properties of PDA films can be modified by adding other polymers to the solution. We utilized poly(L-lysine) (PLL) for

this. PLL is a positively charged polypeptide, which is made of a chain of amino acids – the basic building blocks of proteins. PLL is not only supporting the adhesion of cells, but it is also degradable. The latter aspect is important to allow the tissue to properly integrate or replace the implant. We deposited mixed PDA/PLL films and showed that the more PLL was present the thinner the coating became. This means that the speed the polymer coating is degraded can be controlled – thinner films will be degraded faster. Further, any implant that is put into a body will get in contact with blood. A major concern in this context is that the proteins in the blood are sticking to the implant surfaces, marking it for the immune system to be foreign and unwanted. Therefore, it is important to know how many proteins are adsorbing an implant surface. Proteins bind predominantly via electrostatic interactions to surfaces. In our case, PDA is negatively charged, allowing positively charged proteins to adsorb in an uncontrolled manner. We found that increasing the amount of PLL in the coating reduced the amount of adsorbed proteins. This is due to the fact that the charge of the coating is changing – when adding the positively charged PLL to the negatively charged PDA, the overall charge will become neutral at one point, preventing the electrostatic deposition of proteins.

Simple polymer coatings have been shown to have a positive effect on connecting tissue to implants, but often this is not enough. The addition of drugs into the coatings is required to e.g., prevent bacterial infection or to attract the correct cells. Such drugs are often small molecules, which cannot be stable trapped in polymer coatings similar to paint in a sponge when submerged in water. Therefore, drug deposits, which are larger in size and can be connected to the polymer film, are used - liposomes, small spheres made of lipids, in our case. As drugs we use green lipids to visualize the fate of a potential drug when cells are growing on the coating. We showed that what happens to the green lipids depended on what type of coating was deposited. This offers the opportunity to control how fast and how much of the drug is delivered to the cells, similarly to controlling the drug intake depending on the number and frequency of orally taken pills.

Taken together, we showed that the biointerface can be influenced by a polymer coating and that we can control its effect by the choice of the building blocks.

Publication

Mixed poly(dopamine)/poly(L-lysine) (composite) coatings: from assembly to interaction with endothelial cells.
Zhang Y, Lynge ME, Teo BM, Ogaki R, Städler B
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