Colloid particle adhesion to cells in 3D perfusion constructs

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INTRODUCTION

OBJECTIVES

- Design of a method suitable for an adhesion study in artificial flow system simulating the real conditions of desired end use of created micro and nanoparticles.

- Focus on modelling adhesion in organic tissue: specific adhesion study of antigen-targeting nanoparticles under fluid flow conditions in human body.

MEASUREMENT

FLOW CIRCUIT

Constructed flow circuit consists of:

- inlet and outlet teflon tubes
- peristaltic pump
- termostat
- optical thermometer
- flow through cell
- MRI scanner (Bruker Desktop ICON)

FLOW THROUGH CELL

- Structured one-piece layer (Fig. A, non-specific adhesion).
- Slide-in rack with griddle 3D scaffolds (Fig. B).

FLOW CHARACTERISTICS

- The CFD model of flow (flow rate 1.5 ml/min).
- MRI scans of flow in the tissue model (no turbulences visible).

SCAFFOLDS (cell growth)

- 3D printing
- biocompatible material PLA (Poly-L-lactic acid)

ADHESION

NON-SPECIFIC ADHESION

BASIC LAYERS: simple 3D void structure and Alginate/FeO/SiO₂ microparticles (size = 60 μm)

COMPLEX LAYERS: complex 3D void structure and preparation using Solid Template Method (STM) or 3D printing (Alginate/FeO/SiO₂ microparticles)

BIO-SPECIFIC ADHESION

Immobilized 3D scaffolds overgrown by HT-29 cancer cells with nanoparticles (200 μg/ml) modified by IgG-M75 antibody (top row) and by BSA protein (bottom row)

CONCLUSION

- Novel approach for studying 3D adhesion of microparticles was introduced.
- The flow through cell designated specially to adhesion studies using MRI was designed, manufactured and completed with various 3D differentiated layers, which were also developed and characterized.
- Specific adhesion of nanoparticles modified by specific IgG-M75 antibody on HT-29 cells proved in a stationary medium and was observed also in 3D under flow conditions using MRI technology.

FUTURE

- Continuation of the study of bio-specific adhesion under flow similar to the one in human body.

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