CARS MICROSCOPY FOR THE INVESTIGATION OF ADIPOCYTE-DERIVED STEM CELLS IN TISSUE-MIMICKING 3D-ENVIRONMENTS

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In the future, we envision patient-specific in vitro drug testing where the efficacy of a drug is evaluated on cells harvested from the patient prior to systemic administration. In order to ascertain natural functionality of the cells in vitro, as for example in their metabolism, cells can be incorporated into tissue-mimicking, 3D environments. We are interested in mimicking diseased conditions, in particular of obesity and diabetes, which offer more relevant test conditions and could minimize the number of animal and clinical tests needed, altogether offering a more efficient, expedited and low-cost route for drug development.

Our concept to reach a higher level of adipogenesis, consists of a three-dimensional (3D) in vitro culture of human adipose-derived stem cells (hADSC) in a matrix mimicking the fibrous structure and elastic module of native adipose tissue.

For the study of matrix-cell interactions and eventually drug response of living cells in these tissue-like 3D environments, we use Coherent Anti-Stokes Raman Scattering (CARS) microscopy to target specific molecular vibrations of fatty acids in lipid stores and proteins in the matrices, label-free and non-invasively. The near-infrared excitation, used for the generation of the unique non-linear CARS signal, combines low sample photodamage with high penetration depth. Without any sample preparation, we study the fragile protein matrices hosting the cells, cell-matrix interactions and intracellular molecular dynamics.

Combining the analysis of biological functions and microscopy studies of the intracellular lipids, we found an increased maturation on a polymer fiber matrix as compared to the conventionally cultured cells. In order to further decrease the elastic module of the matrix and to fully incorporate the cells into the culturing matrix, we also investigate the use a composite hydrogel consisting of recombinant-engineered elastin-like proteins and native extra-cellular matrix proteins such as collagen.