Tissue Engineering on Microspheres

Adipose Tissue Derived Stem Cell Tissue Engineering on Gelatin Microspheres

Stem cell based tissue engineering is a revolutionary strategy towards organ regeneration. The adipose derived stem cells (ADSCs) has gained significant interest recently due to its ease of availability in fat tissues obtained from liposuction. The multi-lineage differentiation ability of ADSCs makes them an attractive option for stem-cell therapies. Our group has established a compatible scaffold in gelatin microspheres for the growth and delivery of these cells while maintaining the viability and functionality of the cells. Combined with their well-known drug delivery properties, gelatin microsphere makes an excellent choice of scaffold for the ADSCs. We have shown that ADSCs cultivated on gelatin microspheres can differentiate into various lineages.

Neural Tissue Engineering on PHBV microspheres

Poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV) microspheres have been shown to be an excellent choice of scaffold for neural tissue engineering. When embedded in collagen gel, the cells-microspheres constructs become well connected by neurites. We have established the variability of the neurite growth either in bridging the cells or extending into the hydrogel by tuning the permissiveness of the hybrid scaffold. This well-connected system can easily be translated to clinical application due to its suggested ease of integration with the surrounding neurons and thus offers great possibility in neural regenerative medicine.

Collagen-Based Scaffolds

Engineering Microenvironment of Cells

Collagen is one of the most common extra-cellular matrix proteins in the native tissue environment and has both structural and functional roles in maintaining cell viability. In our group, we have shown that the microenvironment of the cells can be modified by changing the bulk stiffness of the collagen without significantly altering the morphology of the native fibrous nature. The nano and micro-structures of collagen can also be controlled through a play with the thermodynamic driving force in the self-assembly of its fibrils. This modifications allow us to generate collagen gels with a range of physiologically relevant stiffness to regulate the malignancy of carcinoma cells.

Collagen-Mimetic Peptides

Our group has established the intimate relationship between the triple helical structure and the cell-binding functions of collagen by a general peptide sequence of (GPO)_nGFOGER(GPO)_{n}. This sequence has shown to interact with specific integrins in cell adhesion assays and suggest great potential in eliciting other cellular responses.

We have demonstrated that this collagen mimetic sequence can be grafted unto a self-assembling peptide amphiphile system. The peptide amphiphile self-assembles into nanofibres, bearing the bioactive motifs on their surfaces. At high concentration, the nanofibres entangles and results in the formation of a collagen-mimetic hydrogel.

This allows us to create a synthetic material that mimics the natural collagen and would be an excellent substitute for collagen in cell-based regenerative therapies.
Molecularly Imprinted Polymers

Molecularly Imprinted Polymers (MIPs) (antibody mimics) have comparable recognition and binding capabilities to molecules and even viruses. We aim to apply them as artificial receptors or antivirals for infectious disease treatment.

Microalgae: the third generation biofuels

Microalgae is as a good source of third generation biofuels based on its photosynthetic capability, rapid growth and carbon absorption. We have designed many outdoor photobioreactors of different configurations for algal cultivation. The lipids extracted from the algal biomass are used as a source of biodiesel. We also investigate the interactions between microalgae and bacteria, and growth promoting effects of symbionts bacteria on the microalgae have been found.

Biodegradable polymers for drug delivery

DOX-loaded mixed micelles with narrow size distribution and high drug loading capacity to overcome drug resistance in tumor cells. We have been working with Dr Yang Yiyan at IBN in developing different polymers and peptides as materials for anti-cancer drug delivery vehicles.

Biomimetic membrane for water treatment

Aquaporins are transmembrane water channel proteins that selectively transport water through plasma membranes in living cells while rejecting all the other solutes. We have designed a fabricated a novel configuration to mimic nature through the use of vesicles embedded onto membranes as advanced materials for purifying water at low pressures and low energy.