Optonets - 3D engineered neuronal networks

Although neurons were one of the first cell types to be cultured (more than 100 years ago), creating engineered neuronal cultures in 3D scaffolds is a relatively new research field. 3D cultures are considered a good model of the central nervous system, and yet, the use of these cultures is limited due to the fact that their creation and probing is technically challenging in comparison to 2D neuronal cultures.

In this lecture we will describe the engineering and biological aspects of developing and characterizing artificial 3D engineered neural network, the “Optonet”. We will review the biological characteristics of the developing network and the optical probing of the cultures using optogenetic tools and a custom rapid imaging system developed by our group. Using viral agents we have transfected the cells with genes coding for calcium indicators and light gated ion channels, which allows us to visualize the cells activity in response to light patterns projected on the cells. We will demonstrate that the ability to monitor and control the activity of a large population of neurons in the network allows us to study the electrophysiological properties of the network in a controlled manner.

Finally, we will review possible applications for these 3D engineered neuronal networks in basic science, in drug screening and as tissue transplants in cases of neural damage, and will present the preliminary work done in our lab towards those applications.