electrolyte interface. One might question the use of electromanipulation buffers as it results in lower transmembrane transport and possible increased cellular death. Therefore, in this study, effects of electromanipulation buffers with varying salt concentrations on cellular viability and transmembrane transport was studied for a human T-cell leukemia cell line (Jurkat). Cellular viability was measured in vitro using an MTT cell viability assay. Cellular death was also measured using the trypan blue dye exclusion method. Membrane capacitance and conductance was measured by impedance spectroscopy over a range of extracellular salt concentrations. We described the cell membrane conductance at different extracellular salt concentrations using a quantitative model. Even though membrane conductance measurements by impedance spectroscopy is indicative of number and activity of ion channels even performed at low extracellular salt levels; results indicate that cells in electromanipulation buffers have reduced viability. Strategies to increase metabolic activity by changing buffer composition while still retaining the performance of impedance spectroscopy and electromanipulation are also presented.

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Inherently Fluorescent Nanowires for Cellular Mechanosensing

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How mechanical cues trigger cellular events is currently an intensive research area and measuring the forces involved requires multiple and highly sensitive probes. Arrays of vertical nanowires have been shown to measure cellular forces down to 15 pN, providing there is a high precision in the determination of the nanowire deflection1, 2. Current approaches involve the use of either organic fluorophores to coat the nanowires, or scanning electron microscopy (SEM) to determine the deflection of the nanowires. However, organic fluorophores are prone to photo-bleaching and SEM can only measure the forces at a given time point and may also give rise to artifacts due to cell shrinkage during the dehydration step.

Our approach is to use epitaxial, vertical, gallium phosphide (GaP) nanowires with a top-segment made of gallium indium phosphide (GaInP), which is inherently fluorescent3. The nanowires are grown using metal-organic-vapor-phase-epitaxy (MOVPE), which allows for excellent control over nanowire diameter, length and material composition. GaInP is strongly fluorescent and photo stable, which enable the precise determination of the nanowire tips for a long period of time.

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4099-Pos Board B827

CMOS Electrochemical Sensing Platform for Spatially Resolved Detection of Redox-Active Metabolites Released by Multicellular Films

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Despite advances in monitoring spatiotemporal expression patterns of genes and proteins with fluorescent probes, direct detection of metabolites and small molecules remains challenging. Metabolite detection is of particular interest in microbial biofilms. Mass spectroscopy (MS) techniques have been applied to metabolite detection in biofilms, but the instrumentation is bulky and expensive. Additionally, MS techniques focus on probing biofilm top surfaces, which requires various forms of colony treatment such as liquid bridges, imprinting on a substrate, coating with an organic matrix, or incorporation of tags. Scanning electrochemical microscopy (SECM) can be used to study electrochemically active metabolites on the top surface of biofilms in a spatially resolved fashion, but without the ability to quantify concentration or to simultaneously detect multiple redox-active species. Here, we demonstrate spatially resolved detection and profiling of metabolites released from biofilm bottom surfaces by interfacing biofilms to a complementary metal-oxide-semiconductor (CMOS) integrated circuit (IC). The chip contains an array of working electrodes and parallel potentiostat channels. "Images" over a 3.25-mm-by-0.9-mm area can be captured with a spatial resolution of 750 μm limited currently by diffusion through the thin (1-mm) agar film interfacing the biofilm with the chip. Using this platform, we demonstrate that square wave voltammetry (SWV) can be used to detect, identify, and quantify (for concentrations as low as 2.6 μM) four distinct phenazines, redox-active metabolites produced by *Pseudomonas aeruginosa* PA14. We characterize phenazine production in both wild-type and mutant *P. aeruginosa* PA14 colony biofilms, and find correlations with fluorescent reporter imaging of phenazine gene expression. Key to the methods developed in this work is the exploitation of IC technology as a new tool for biology, enabling many measurement channels and electrodes to be fabricated within a very small area.

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An Integrated Liver- and Heart-On-A-Chip Platform

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Engineering microfluidic devices to mimic human organs' microenvironments addresses many of the challenges of in vivo models, such as the lack of controllability and repeatability, and conventional static in vitro models, including deficiency in mimicking organ complexities. Due to these advantages, "organ-on-a-chip" platforms have gained significant interest for drug screening and studying the biophysics of physiologically relevant microenvironments. Here, we present an integrated heart- and liver-on-a-chip platform by culturing human induced pluripotent stem cells-derived cardiac myocytes (hiPSC-CMs) and hepatocytes (hiPSC-HPs) in a single microfluidic chip. Since the failure of most of drugs is regarded to the toxicity or dysfunction of these two organs, simultaneous and integrated investigation of the biophysics of toxicology on the liver and heart is essential. A dynamic fluid transport system was engineered by creating endothelial-like barriers to mimic continuous nutrient exchange and cell-cell interaction observed in ventricular myocardium and liver sinusoid. Moreover, using microfluidic channels, the blood flow between liver and heart was mimicked. Laminar fluid flow in these microchannels provides a predictable and spatially and temporally controllable microenvironment to study the biophysics for these two organs on chips. This model not only gives us the ability for testing the effects of heart diseases' drugs on the functionality of the cardiac and liver cells simultaneously, but it also presents the role of detoxification on the heart performance. The effect of different parameters, such as flow rate, was investigated by real time monitoring of the cultured cells morphology and metabolism. The capability of our device for long-term culturing of iPSC-derived liver and cardiac cells was also presented, which is critical for patient-specific drug discovery. We believe that this integrated organ-on-a-chip platform provides new possibilities for the future of drug screening and personalized medicine.

4101-Pos Board B829

High-Throughput Single-Cell Analysis Device for Following Simultaneous Intracellular Signaling Events

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Investigating the behavior of single cells in a high-throughput manner calls for the design and realization of innovative, robust and versatile devices capable of conducting adaptable experiments to address the desired biological questions. For instance, the possibility of running experiments that compare the reaction of different cell types to a specific stimulus or the effect of a given substance at different concentrations on a specific cell type is highly desirable. One inherent challenge associated with running such experiments, however, is the existence of random uncertainty factors from experiment to experiment. Examples of this could be common measurement errors in preparing exact substance concentrations or the likeness of consecutive cell cultures.

Here, we report the design and fabrication of a high-throughput microfluidic platform intended for parallel investigations on single cells upon extracellular environmental changes.

We fabricated a hydrodynamic-based cell isolation microfluidic block in polydimethylsiloxane (PDMS) with two secluded entities. The comb-shaped trapping zone in each entity consists of 52 V-formed individual traps. Each trap has the dimensions of 10 μm × 10 μm and connects two complement microchannels via a 2-μm wide confinement opening. After the cell-loading step, isolated cells can undergo several chemical-rinsing steps and, in combination with fluorescence microscopy imaging, cellular response can be read and analyzed. This easy-to-operate, parallel microfluidic platform enables the simultaneous comparison of the read out between two portions of a particular cell passage to various chemical stresses or different concentrations of one specific stimulus.