The cell adhesion process and apoptosis monitored with the piezoelectric sensor

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INTRODUCTION: The cell adhesion process was studied due to its relevant role in many biological research areas. The complex view into the mechanism of the cell adhesion can be obtained using the quartz crystal microbalance technique (QCM). This approach enables to record a shift in the resonant frequency and/or resistance of the sensor during the cell attachment and spreading on the surface. QCM responses are markedly different according to the cell type and number, adhesion power and vitality. Several ECM proteins were tried as coatings improving cell attachment on the gold surface. Finally, apoptosis due to the effect of drugs was monitored with QCM as well.

METHODS: The 10 MHz quartz crystal with gold electrodes on both sides was placed on the bottom of the thermostated measurement chamber. For different experiments the electrodes were used uncoated and pre-coated either with laminin (2 μg/cm^2), fibronectin (10 μg/cm^2) or vitronectin (0.1 μg/cm^2). Two cell lines such as rat epithelial cells (WB F344) and lung melanoma cells (B16F10) were cultured for the comparison and seeded on the sensor at the appropriate density. The shifts of the resonant frequency and resistance were monitored in real-time over the 1 day cultivation. Next, the presence of cells on the sensing surface was detected using the fluorescent microscope (MitoTracker Red CMXRos staining). The apoptosis was initiated with the addition of α-TAM (derivate of vitamine E) at 300 μM to the established confluent layer of cells and simultaneously microscopically compared with the standard microplate experiment.

RESULTS: Fig.1 shows the typical and expected result of the cell adhesion process on the vitronectin-modified surface. The resonant frequency was decreasing and resistance increasing because of viscoelastic properties of the adhering cells. Similar results were achieved with the bare electrode and fibronectin coated surface as well. The different result was obtained with laminin. This surface was promoting cells attachment but the electrochemical signal was contrary to the surfaces mentioned previously. A marked change was also between two cell lines. A steeper decrease in resonant frequency and a larger increase in resistance were obtained with B16F10 cells compared to WB F344 cells. Regarding the QCM response of cells after the drug addition the frequency sloped down and the resistance was slightly increasing.

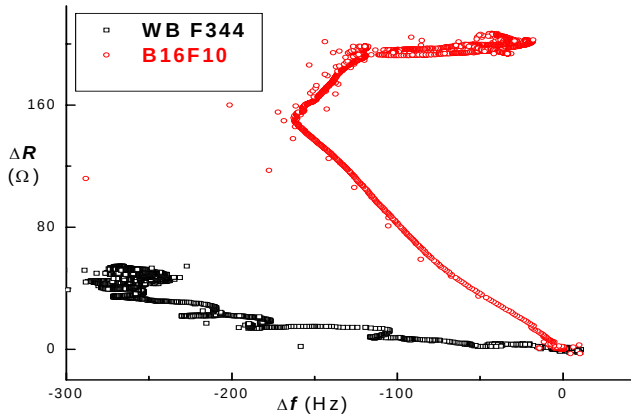

Fig. 1: Dependence of the resistance on the resonant frequency during cells attachment process on the vitronectin coated sensing surface.

DISCUSSION & CONCLUSIONS: Piezoelectric sensor is a suitable device for monitoring of adherent cells on modified surfaces. Real-time monitoring of cellular processes allows to achieve more detailed information compared to standard microplate-based cultivation techniques. The tested cell lines were successfully combined with modified sensing surfaces, thus obtained cell-based biosensors are promising for convenient testing of physiologically active compounds as novel drugs, which modify either metabolic activity or morphologic properties of the attached cells

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