

Multimodal Measurement of Apoptosis – Integration of Biosensing, Imaging, and Analysis

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Abstract

Apoptosis is a highly regulated form of cell death. Currently, the established methods for apoptosis detection include observation of cell morphology and probing of DNA fragmentation. These methods focus on the detection of changes that occur later in the apoptotic process. Nevertheless, detection of apoptosis at the early stages, prior to gross morphological changes, is critical for understanding the entire apoptotic pathway and for providing the possibility to intervene and enhance longevity and productivity of cell cultures used to produce biologicals. A group of proteases known as caspases act together in a cascade to cleave proteins at aspartic acid residues. This proteolytic cascade amplifies the apoptotic signalling pathway and thus leads to rapid cell death. In this paper, an impedance spectroscopy technique using non-Faradaic measurement of caspase-9 was combined with fluorescence-based light microscopy including an associated macro-based image analysis suite for ImageJ in a multimodal approach. Whereas the biosensor measurements provide a cell population overview, the microscopic analysis provides individual cell analysis. Combined, these approaches allowed us to detect cells in the early stages of apoptosis in the cell population. We believe these complementary methods will allow us to follow the progression of apoptosis in cells more accurately and give us a handle to intervene at early stages of apoptosis.

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