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Bioanalytical Approaches for Monitoring Cellular Communication

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Summary

Islets of Langerhans are the endocrine portion of the pancreas and are composed of several cell types that release peptide hormones into the bloodstream for regulating glucose levels. Proper control of blood glucose is dependent on the amounts and dynamics of hormones released from these cells. Defects in the secretion of these hormones are associated with a number of metabolic diseases, including diabetes and the metabolic syndrome. Because the dynamic profiles of hormone secretion are essential to proper glucose control, examining secretion from single or small groups of islets are essential, necessitating analytical tools with high sensitivity.

In this talk, a number of analytical strategies our group has developed which enable monitoring secretion of hormones and small molecules released from islets with high time resolution will be discussed. Microfluidic systems are an ideal platform to interrogate islets as they reduce dilution of the secreted components and can be used to deliver complex glucose profiles like those observed in vivo. We have developed a number of analytical approaches that use microfluidic systems to measure hormone and small molecule secretions from single or small groups of islets of Langerhans. Initially, microfluidic electrophoretic immunoassays were used to measure insulin secretion from single islets. While highly sensitive, they were difficult to use due to the shallow channels required to limit Joule heating. As such, a homogeneous fluorescence anisotropy competitive immunoassay for insulin was developed which allowed for larger channels to be used [1]. To increase the throughput of the assay, a fluorescence anisotropy imaging system was employed for measurement of insulin secretion from 12 groups of islets in parallel with minimal fluidic inputs [2]. To automate the system further microfluidic valves and other fluidic elements were implemented [3]. Finally, antibody-free assays using LC- and SPE-MS/MS providing multi-analyte monitoring of hormone secretion will be described [4]. These systems offer the potential for combining the benefits of microfluidics with high information content detection.

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