**Journal of Diabetes Science and Technology**
Volume 3, Issue 6, November 2009


ORIGINAL ARTICLES

# A Benchtop Closed-Loop System Controlled by a Bio-Inspired Silicon Implementation of the Pancreatic β Cell

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## Abstract

The normal pancreatic β-cell membrane depolarizes in response to increasing concentrations of glucose in a bursting pattern. At <7 m*M* (126 mg/dl), the cell is electrically silent. The bursting pulse width increases as glucose rises >7 m*M* (126 mg/dl) until a continuous train of bursting is seen at >25 m*M* (450 mg/dl). A bio-inspired silicon device has been developed using analogue electronics to implement membrane depolarization of the β cell. The device is ultralow powered, miniaturized (5 × 5 mm), and produces a bursting output identical to that characterized in electrophysiological studies.

### *Objective:*

The goal of this study was to demonstrate the ability of silicon implementation of β-cell electrophysiology to respond to a simulated glucose input and to drive an infusion pump *in vitro*.

### *Method:*

The silicon device response to a current source was recorded at varying simulated glucose concentrations. Subsequently, the bursting response to a changing analyte concentration measured by an amperometric enzyme electrode was converted to a voltage, driving a syringe pump loaded with a 50-ml syringe containing water.

### *Results:*

Bursting responses are comparable to those recorded in electrophysiology. Silicon β-cell implementation bursts with a pulse width proportional to concentration and is able to drive an infusion pump.

### *Conclusion:*

This is the first *in vitro* demonstration of closed loop insulin delivery utilizing miniaturized silicon implementation of β-cell physiology in analogue electronics.

*J Diabetes Sci Technol 2009;3(6):1419-1424*

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**Abbreviations:** (ATP) adenosine triphosphate, (CMOS) complementary metal oxide semiconductor

**Keywords:** β cell, closed loop, type 1 diabetes

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