

DIABETES

Novel Insights and Therapies



Anas Islam
Badruddeen
Editors



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CHAPTER 10

Synthetic Innovations: Engineering Solutions in Diabetes

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ABSTRACT

The global increase in diabetes incidence necessitates the investigation of innovative management strategies for this chronic illness. Advances in synthetic innovations are crucial to address the complexities of diabetes treatment. The convergence of synthetic biology and engineered biological systems has fostered novel therapeutic methods, particularly for insulin administration and glucose management. Key innovations include engineered cells, encapsulation techniques, and biohybrid devices that enhance diabetes management while minimizing the frequency of insulin injection. These synthetic advancements are transforming diabetes care by designing biological systems for specific functions, such as insulin release in response to glucose levels. This domain has the capacity to develop advanced therapies that replicate natural glucose regulation by pancreatic β -cells, thereby offering an alternative to conventional treatment methods.

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Significant progress has been made in glucose-responsive synthetic systems and nanomedicines that regulate insulin release according to glucose elevation, emulating β -cell functionality. These novel approaches promise to enhance the quality of life of patients with diabetes by facilitating natural glucose control.

10.1 INTRODUCTION: THE STORY OF DIABETES

The historical chronology of diabetes can be delineated over a span exceeding 3500 years, originating in ancient Egypt, where the earliest documented reference to this ailment was inscribed on the Ebers Papyrus circa 1550 BCE. This manuscript elucidates the condition characterized by polyuria; a clinical manifestation presently acknowledged as indicative of diabetes mellitus (Carpenter et al., 2006). Ancient Indian medical practitioners observed the sweetness present in the urine of individuals with diabetes, calling it “madhumeha,” which translates to “honey urine” (Lakhtakia, 2013).

The word “diabetes” originates from the Greek word “siphon,” introduced by the Greek physician Aretaeus of Cappadocia in the 2nd century CE to describe a condition in which patients appeared to “pass water like a siphon” (Retief and Cilliers, 2009). The term “mellitus,” meaning “honey-sweet,” was later added by British surgeon Thomas Willis in the 17th century to differentiate this condition from diabetes insipidus, which does not involve sugar metabolism (Willis, 1674).

During the Middle Ages, diabetes was widely misunderstood and believed to be a disorder of the kidneys or other organs. Treatments were basic and generally ineffective, consisting of dietary restrictions, herbal remedies, and bloodletting (Tattersall, 2009).

Significant advances in the understanding and management of diabetes began in the 19th century. In 1869, Paul Langerhans, a German medical student, identified clusters of cells in the pancreas, later named the Islets of Langerhans. These cells produce insulin, a hormone essential for regulating glucose (Tepperman, 1988).

The most crucial advancements in the history of diabetes occurred in the early 20th century. In 1921, Canadian researchers Frederick Banting and Charles Best, with the assistance of John Macleod and James Collip, successfully isolated insulin and demonstrated its effectiveness in reducing blood glucose levels (BGLs) in diabetic dogs. The first successful insulin treatment