Editorial

Avicenna Journal of Medical Biotechnology
Volume 16, Issue 2, 66-67
https://doi.org/10.18502/ajmb.v16i2.14854

The Role of Biotechnology in Latest Therapeutic Approaches for Diabetes Mellitus

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Received: 22 Jan 2024
Accepted: 22 Jan 2024

Diabetes Mellitus (DM), a common chronic disease resulting from interactions between environment and genetics, is mainly represented in two main types, T1DM and T2DM, considering whether the insulin is produced less than required or used ineffectively. The dramatically increasing burden of DM is described as an estimated global economic burden of US$ 825 billion and 3.8 million deaths related to diabetes from 2012 to 2015 [1]. Based on the DM type, pathogenesis, and complications of the disease known as Diabetes Mellitus-Related Conditions (DMRC), diverse therapeutic approaches such as lifestyle change, oral agents, insulin therapy, and sometimes islet or whole pancreas transplantation are suggested. Despite advancements in medicine, curing increased blood glucose levels and the subsequent DMRCs are still goals to meet [2]. Biotechnology, a pivotal multidisciplinary field in therapeutic approaches for various diseases, likewise has an impressive role in different therapeutic approaches for DM.

Insufficient or defective insulin as the leading cause of DM resulted in insulin therapy as an efficient therapeutic approach in DM. Improving insulin treatment over time through biotechnology is moving towards altering action periods, durability, and delivery routes. In 2014, the European Union approved the first biosimilar insulin. Novel forms of insulin are being developed as biosimilar insulins, which are more complex, have similar properties with lower costs than the reference product, and are one of the outputs of biotechnology in medicine [3]. Various insulin delivery options are introduced, such as oral insulin tablets, insulin pumps, inhaler insulins, and biosynthetic pancreas. Continuous subcutaneous insulin infusion is used to imitate basal insulin production, in which a particular insulin dose will be delivered to the body with a small pump [4]. Automated insulin delivery systems are the mechanisms of the artificial pancreas, which is also called a closed-loop glucose system. These systems utilize the control algorithm to adjust the infusion amount of insulin automatically with the blood glucose level at the time, which improves the efficacy and safety of insulin therapy [5]. Since decreasing the swing of serum glucose levels has been one of the goals of Insulin Replacement Therapy (IRT), the rise of glucose-responsive insulin-delivery technologies as smart systems are novel approaches for IRT. Altering the structure and bioavailability of insulin analogs based on glucose concentration without the need for external monitoring is the prospect of this novel approach [6].

Stem cell transplantation, as one of the principal treatments for autoimmune diseases, is reported as a practical approach for improving T1DM as an autoimmune disease. The combined transplantation of Mesenchymal Stem Cells (MSCs) and Hematopoietic Stem Cells (HSCs) amended T1DM by reducing the total daily use of insulin and HbA1c levels [7]. Studies indicate that the differentiation of MSCs can lead to the generation of Insulin-Producing Cells (IPCs) with tissue engineering techniques. Scaffolds can provide the microenvironment that enhances the differentiation of MSCs to IPCs, increases metabolic activity, produces insulin and pancreatic-specific transcription factors, and prevents cell death [8]. As mentioned before, islet transplant as a cell-based therapy is considered in DM treatment and enhanced post-transplantation insulin independence to 5 years in 50% of patients undergoing the intervention. Based on the limitations of this method, tissue engineering is needed for developing extracellular matrix molecules for insulin-producing cells in three-dimensional (3D) structures to make cells more viable and potent for secreting insulin and use encapsulation to limit the host's immune attack [9]. Various islet-encapsulating methods, including macro-, micro-, and nano-encapsulation and bioprinting, exist but have limitations that hinder the widespread implementation in the clinical phase [8].

Anti-CD3 monoclonal antibodies indicated improvements in HbA1c levels and had a potential role in reducing the exogenous insulin dependency in patients with new-onset T1DM by preserving beta cell function [10]. The crucial role of Gut Microbiota (GM) as the human's second genome is represented in many diseases, including T1DM. According to

the results of the evidence, GM is significantly altered in T1DM. Hence, insulin resistance and glycemic control can be improved by fecal microbiota transplantation by modulating the gut microbiota in T1DM patients [11].

Research has led to substantial improvements in the control of DM. Nevertheless, despite all of the remarkable advances in the treatment of DM, managing DM and the complications of the disease are still under investigation. Some of the introduced approaches are not well-used for reasons such as high costs, complications, and uncertainty regarding safety. There is no doubt, cooperation between basic sciences, especially neuroscience and biotechnology, and internal medicine can create a brighter future for the treatment of endocrine diseases [12-16]. Representing solutions to overcome the limitations, optimizing, expanding, and proving the safety of the presented methods by well-designed clinical trials are the future perspectives for research in this field. More investigations for more advanced discoveries with the fundamental assistance of biotechnology are essential.

Keywords: Artificial pancreas, Gastrointestinal microbiome, Glucose, Insulin, Monoclonal antibody, Stem cell transplantation, Tissue engineering, Treatment

Acknowledgement

This paper received no specific grant from public, commercial, or not-for-profit funding agencies.

Conflict of Interest

The authors had no competing interests.

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