Review Article

Recent Advancement in Nanobetes

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ABSTRACT

Diabetes is a metabolic disease characterised by chronically elevated blood glucose level (BGL) and inability to maintain the blood glucose level homeostasis1,2. Diabetes has grown to become one of the largest public health challenges globally 382 million worldwide3,4. Concordant usage of insulin therapy and other detecting methods (pin prick) to withdraw blood are painful and lead to patient non compliance4. The recent trends in nanotechnology in diabetes have developed the novel glucose measurements and insulin delivery modalities, which improves the patient's safety and quality of life. This article reveals about the application of nanotechnology (Nanomedicine) in diabetes, which brings a new outlook and advancement in the treatment and management of diabetes.

INTRODUCTION

Nanotechnology offers sensing technologies that provide more accurate and timely medical information for diagnosing disease. The prevalence of diabetes is rapidly rising all over the globe at an alarming rate. The application of nanotechnology to medicine holds many possible advantages, Nano-medicine has also enabled more robust insulin delivery systems that can detect fluctuation in blood glucose levels and automatically modulate the rate of insulin release to maintain normoglycemia[4].

Diabetes

Diabetes mellitus often referred as diabetes is caused by decrease in insulin secretion by pancreatic islets of cells leading to increases in blood glucose level (Hyperglycemia), similarly, diabetes insipidus is a condition characterised by polyuria, polyphagia, polydypsia and also due to the deficiency of (ADH) vasopressin[5]. Gestational diabetes is when pregnant women, who have never had diabetes before, have a high blood glucose level during pregnancy and other forms of diabetes mellitus include congenital diabetes, which is due to genetic defects of insulin secretion, cystic fibrosis- related diabetes, steroid diabetes include by high dose of glucocorticoids and several forms of monogenic diabetes. Adequate treatment of diabetes is thus important, as well as blood pressure control and lifestyle factors such as smoking, alcohol and maintain a healthy body weight.

Nanotechnology in Diabetes (Nanobetes)

Nanotechnology possesses rapid advances in the treatment and diagnosis of Diabetes. By diagnosis it can be achieved by following ways by microphysiometer and implant sensor, similarly in treatment by development of microsphere for oral insulin production, artificial pancreas and Nanopump.

Microphysiometer

It is multi walled carbon nanotubes, which are like several flat sheets of carbon atoms stacked and rolled into very small tubes. It is used to detect and monitor the response of cells to variety of chemical substance like ligand specific plasma membrane receptors. The nanotubes are electrically conductive and the chamber can be directly related to the current at the electrode and the nanotubes operate reliably at pH levels of living cells[6].
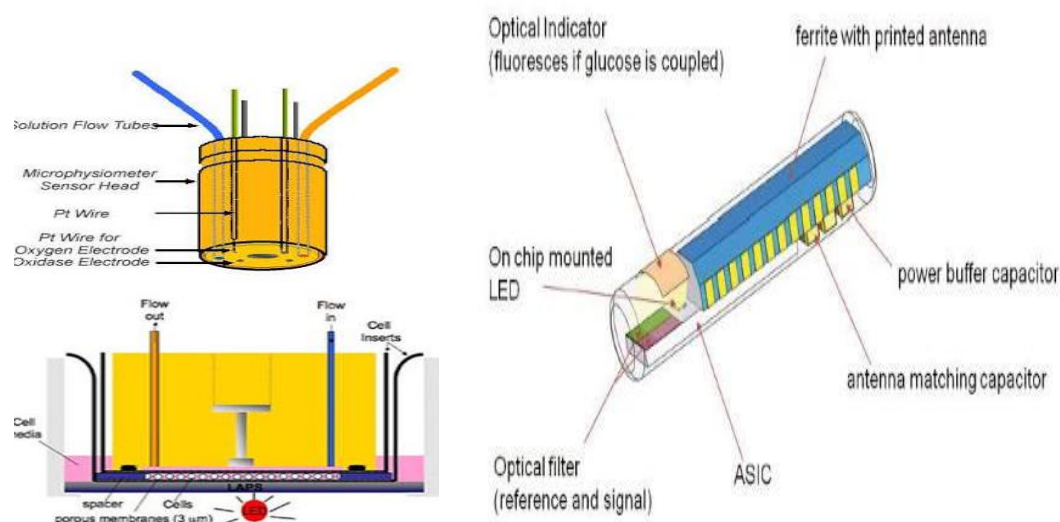
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Fig. 1 Microphysiometer and Implantable Sensor

Implantable sensor

It is used for monitoring of tissue glucose concentration by wireless telemetry for the eventual application in people with diabetes. The implantable sensor is designed to give diabetes patients an alternative to finger-sticking of short term glucose sensors, as well as limit dangerous glucose level fluctuation known as "glucose excursions". Sensor micro chips are also being developed to continuous monitor key body parameters including pulse, temperature and blood glucose. A chip would be implanted under the skin and it transmits the signals continuously[7].

Microsphere for oral insulin:

By the use of microsphere system in case of oral insulin it may be protected from gastric enzymes and proteolytic degradation in stomach and upper part of gastro intestinal tract. It may act as encapsulating membrane against degradation within its matrix and permeation enhancers by effective crossing the epithelial layer after oral administration.
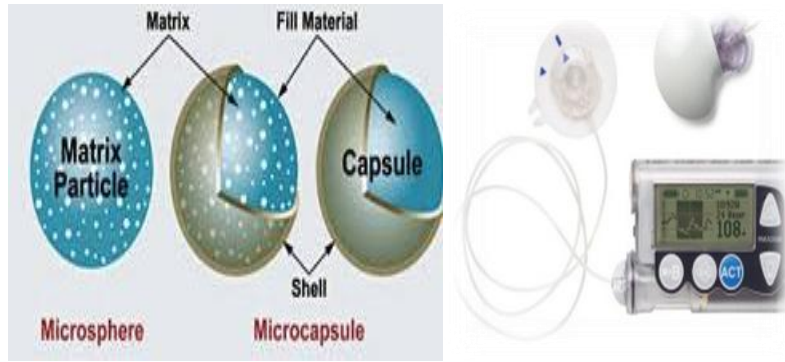
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Fig. 2: Microsphere and Nano pump

Nanopump

Nanopumps are used to inject the insulin to the patient's body in constant rate, balancing the amount of sugars and also the pump can administer small drug doses over a long period of time [8].

Artificial pancreas

Development of artificial pancreas could be the permanent solution for diabetic patients. The concept of work is simple; a sensor electrode repeatedly measures the level of blood glucose; this information feeds into a small computer energizes an infusion pump, and needed unit of insulin enter the blood stream from a small reservoir. When glucose level increases, the sensors on the surface would record it and insulin would be released [9].
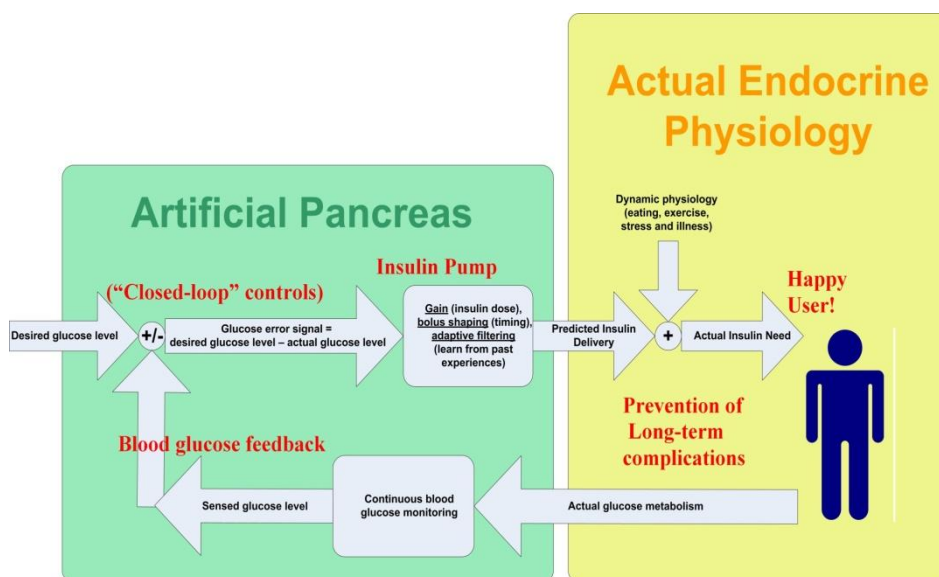

Fig. 3: Artificial Pancreas

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Advantages and limitations for limited different type of Nanoparticles.

Type of Nanoparticles	Advantages	Limitations
Polymeric Nanoparticles	Degrade into biological compound, less cytotoxicity, high level of insulin entrapment	Mucoadhesive polymeric Nanoparticles may adhere non specifically to surface
Ceramic Nano particles	High bio compatibility, protect against denaturation, does not undergo swelling & porosity changes	Poor permeability across the mucosal membrane and rapid mucociliary clearance
Gold Nanoparticles	Long term stability, good insulin loading, improved pharmacokinetic activity of insulin	Widespread distribution in organs like liver lungs, spleen, brain, heart, stomach and joints.
Liposomes	Bio degradable, nontoxic and nonimmunogenic	Drug loading capacity remains inconclusive.

CONCLUSION

The science and knowledge that the scientific community has today about nanotechnology and its potential versatile applications in only based on research work are being conducted to understand how matter behaves at the Nanoscale level. Nano Particles have larger surface area when compared to their volume. Diabetes is a rapidly growing global problem, which requires management at the patient level, via blood glucose level control prevent worsening effects of the diseases, nanotechnology has proven beneficial in this case by not only increasing the available surface area of the sensor – receptor complex but also by improving the catalytic properties of the electrode and providing Nanoscale sensors. There are some other avenues of nanotechnology that may benefit the treatment as well as curing of diabetes in the future.

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