ABSTRACT
Diabetes mellitus is a metabolic disorder resulting from a defect in insulin secretion, insulin action, or both. Insulin deficiency, in turn, leads to chronic hyperglycemia with disturbances of carbohydrate, fat and protein metabolism. It is the most common endocrine disorder with an increasing global prevalence and incidence. High blood glucose levels are symptomatic of diabetes mellitus as a consequence of inadequate pancreatic insulin secretion or poor insulin-directed mobilization of glucose by target cells. Diabetes mellitus is aggravated by and associated with metabolic complications that can subsequently lead to premature death. Hence this review article provides the comprehensive information on the diabetes mellitus in terms of history, biochemistry, role of insulin, economic burden, management along with future perspectives.

KEYWORDS: Diabetes mellitus; Insulin, blood glucose levels; islets of Langerhans; hyperglycemia.

INTRODUCTION
Diabetes mellitus is a common and very prevalent disease affecting the citizens of both developed and developing countries. It is estimated that 25% of the world population are affected by this disease. It is a metabolic disorder as a result of lack of insulin, defective insulin action, or both. Insulin deficiency, in turn, leads to chronic hyperglycaemia with disturbances of carbohydrate, fat and protein metabolism. [1-3]

Classification of diabetes mellitus is based on its aetiology and clinical presentation. As such, there are four types or classes of diabetes mellitus viz; type 1 diabetes, type 2 diabetes, gestational diabetes, and other specific types. Type 1 diabetes is said to account for only a minority of the total burden of diabetes in a population, although it is the major type of the
diabetes in younger age groups as the majority of well-to-do countries. The incidence of type 1 diabetes is increasing in both rich and poor countries. Furthermore, a shift towards type 1 diabetes occurring in children at earlier ages is imminent.[2]

Type 2 diabetes was previously called non-insulin-dependent diabetes mellitus (NIDDM) or adult-onset diabetes. 85 to 95% of all diabetes in high-income countries is of type 2 accounting for an even higher dominance in developing countries. It is intimately associated with improper utilization of insulin by target cells and tissues. It is currently a common and serious health concern globally. According to World Health Organization (1994), this problem has been aggravated by rapid cultural and social dynamics, ageing populations, increasing urbanization, dietary changes, reduced physical activity and other unhealthy lifestyle and behavioral patterns. Diabetes mellitus and lesser forms of glucose intolerance, particularly impaired glucose tolerance, can now be found in almost every population in the world and epidemiological evidence suggests that, without effective prevention and control programs, diabetes will likely continue to increase globally.[4]

Gestational diabetes mellitus refers to the onset or initial recognition of glucose intolerance during pregnancy, usually in the second or third trimester.[1] The hormones of pregnancy cause insulin resistance and often this form of diabetes disappear after delivery of the baby. It occurs in about 4% of all pregnancies. In Asia, the incidence of gestational diabetes has increased dramatically with 10-15% of all pregnancies affected. The problems related to gestational diabetes are significant and can affect the health of the foetus and the mother. There is a higher risk of abortions, stillbirths, foetal abnormalities and the need for caesarean sections. The baby has a greater risk of being born either small for gestational age with a low birth weight or macrosomic (high birth weight, typically > 4 kg) and be at risk of developing severely low blood glucose levels in the newborn period. Women who have had gestational diabetes have an increased risk (as high as 30-70%) of subsequently developing type 2 diabetes. Breast feeding should be encouraged and obesity avoided by discouraging over-feeding with nutrient-rich formulae, especially of the low-birth weight babies.[5]

Other types include genetic defects of the pancreatic β cell or in insulin action pathways (insulin receptor mutations or post-receptor defects) as well as disease of the exocrine pancreas (e.g. pancreatitis, pancreatic reaction, or cystic fibrosis) are less common causes of diabetes mellitus. Endocrinopathies producing insulin counterregulatory hormone excess (e.g. Cushing’s syndrome, acromegaly) may result in diabetes mellitus. Certain drugs like
glucocorticoids, pentamidine, niacin, and SA-interferon may also lead to diabetes mellitus.[1, 6-7]

Diabetes mellitus, a major lifestyle disease is undoubtedly the most challenging public health problems of the 21st century with a worldwide.[8] The prevalence of diabetes is rapidly rising globally. World Health Organization reports show that 32 million people had diabetes in the year 2000.[9] The International Diabetes Federation estimates the total number of diabetic subjects to be around 40.9 million in India and this is further set to rise to 69.9 million by the year 2025.[12] India leads the world with the largest number of diabetic subjects earning the title “Diabetes capital of the world”. Diabetes, which was known to be an epidemic in urban areas have found to be increasing rapidly in rural areas too, as a result of the socioeconomic transitions. It is no longer only disease of the elderly, but is one of the major causes of morbidity and mortality affecting youth and middle aged people.[10]

The debilitating effects of diabetes mellitus include various organ failures, progressive metabolic complications such as, retinopathy, nephropathy, and/or neuropathy.[11] Diabetics are accompanied by risk of cardiovascular, peripheral vascular and cerebrovascular diseases. Several pathogenetic processes are involved in the development of diabetes, including destruction of pancreas β-cells that lead to the lowered sensitivity of insulin action.[4]

Diabetes is also known as a “silent disease,” exhibiting no symptoms until it progresses to severe target organ damage.[12] Because of the increasing burden of the disease, its iceberg nature, its complications and potential to prevent these complications with earlier diagnosis and treatment, active and opportunistic efforts are required for early diagnosis of diabetes by means of screening.[13] Early identification of at-risk individuals and appropriate lifestyle intervention would help in preventing or postponing the onset of diabetes mellitus. Hence, the present review article explores diabetes mellitus in terms of various aspects.

**ETYMOLOGY**

The terms "Diabetes" and “Mellitus” are derived from Greek. “Diabetes” denotes "a passer through; a siphon" whereas the "Mellitus" denotes "sweet". It is thought that the Greeks named it so due to the excessive amounts of urine produced by diabetics attracted flies and bees. The traditional way of diagnosing diabetes mellitus in ancient Chinese was by observing whether ants are attracted to a person's urine or not. In medieval ages, the
European doctors tested for diabetes by tasting the urine themselves, a scene occasionally depicted in Gothic beliefs.\textsuperscript{14}

**HISTORY**

Throughout most of its history, diabetes mellitus was considered classified and promulgated as a disease of the kidneys. It was only in the latter part of the 19\textsuperscript{th} century, when chemistry and physiology moved medicine from an observational to an investigative science, that it first came to be defined as a metabolic and shortly thereafter as an endocrine disease.\textsuperscript{15} Diabetes mellitus has been known since antiquity, its treatments were known since the middle ages, and the elucidation of its pathogenesis occurred mainly in the 20\textsuperscript{th} century. Non-progressing Type II diabetics almost went undiagnosed.\textsuperscript{14} The discovery of the role of the pancreas in diabetes was made by Joseph Von Mering and Oskar Minkowski in 1889. They found that upon complete removal of the pancreas from dogs, the dogs exhibited all the signs and symptoms of diabetes and died shortly afterwards. In 1910, Sir Edward Albert Sharpey-Schafer of Edinburgh in Scotland suggested that diabetics lacked a single chemical which was normally produced by the pancreas. The name of this chemical was later proposed to be insulin.\textsuperscript{4}

In 1921, Frederick Grant Banting and Charles Herbert Best repeated the work of Von Mering and Minkowski but went a step further and managed to show that they could reverse the induced diabetes in dogs by giving them an extract from the pancreatic islets of Langerhans of healthy dogs. This was a step forward in elucidation of the endocrine role of the pancreas in metabolism and existence of insulin. These scientists proceeded on to isolate insulin from bovine pancreases at the University of Toronto in Canada, thereby leading to the availability of an effective treatment of diabetes mellitus, with the first clinical patient being treated in 1922. The distinction between what is now known as type I and type II diabetes was made by Sir Harold Percival (Harry) Himsworth in 1935.\textsuperscript{4}

Following these discoveries, another landmark discovery followed viz; identification of sulfonylureas in 1942, the radioimmunoassay for insulin, as discovered by Rosalyn Yallow and Solomon Berson, Reaven's introduction of the metabolic syndrome in 1988 and identification of thiazolidinediones as effective antibiotics in the 1990.\textsuperscript{14}
BIOCHEMICAL PERSPECTIVES

A regular energy source is a prerequisite for every cell to function in the human body. Glucose is the body’s primary energy source, which circulates in the blood as a mobilizable fuel source for cells.[11,16-17] Insulin is a pancreatic hormone responsible for blood glucose level regulation. It is a polypeptide synthesized in humans and other mammals within the beta cells of the isles of Langerhans in the pancreas. The islets of Langerhans form the endocrine part of the pancreas, accounting for 2% of the total mass of the pancreas, with beta cells constituting 60-80% of all the cells of islets of Langerhans.[4] This hormone binds to its receptor sites on the peripheral side of the cell membranes. It affords entry of glucose into respiring cells and tissues via requisite channels. Insulin stimulates catabolism of glucose into pyruvate through glycolysis. It also upregulates glycogenesis from excessive cytosolic glucose and lipogenesis from excessive cytosolic acetyl-COA. These metabolic events are antagonistic to metabolic events triggered by the hormone glucagon. When glucose levels are at or below threshold, glucose stays in the blood instead of entering the cells.[18] The body attempts to arrest hyperglycemia, by drawing water out of the cells and into the bloodstream. The excess sugar is excreted in the urine. This is why diabetics present with constant thirst, drinking large amounts of water, and polyuria as the cells try to get rid of the extra glucose. This subsequently leads to glucosuria.[11] As hyperglycemia prolongs, the body cells are devoid of glucose due to the lack of insulin. This forces the cells to seek alternative mobilizable energy sources. In this regard, the cells turn into fatty acids stored in adipose tissue. Fats are not fuel sources for the red blood cells, kidney cortex and the brain. The red blood cells lack mitochondria in which beta-oxidation pathway rests. The fatty acids cannot pass the blood-brain barrier. To avail energy to such cells and tissues, the acetyl-CoA arising from catabolism of fatty acids is diverted to ketogenesis to generate ketone bodies, which can serve as alternative fuel sources for such cells and tissues. These ketone bodies are also passed in the urine, thereby leading to ketonuria, which characterizes diabetes mellitus. Build up of ketone bodies in the blood produces ketosis. Ketone bodies are acidic in nature and therefore, they build up in blood and lowers blood pH, leading to acidosis. A combination of ketosis and acidosis lead to a condition called ketoacidosis. If left untreated, ketoacidosis leads to coma and death.[18]

ROLE OF INSULIN

Insulin exhibits a multitude of effects in many tissues, with liver, muscle, and adipose tissue being the most important target organs for insulin action. The basic physiological function of
insulin is promoting the synthesis of carbohydrates, proteins, lipids, and nucleic acids. The effects of insulin on carbohydrate metabolism include stimulation of glucose transport across muscle and adipocyte cell membranes, regulation of hepatic glycogen synthesis, and inhibition of glycogenolysis and gluconeogenesis. The end result of these actions is a reduction in blood glucose concentration. With regard to protein metabolism, insulin promotes transfer of amino acids across membranes, stimulates protein synthesis and inhibits proteolysis. Incorporation of fatty acids from circulating triglyceride into adipose triglyceride and lipid synthesis are stimulated by insulin; lipolysis is inhibited. Insulin contributes to nucleic acid synthesis by stimulating the formation of ATP, DNA and RNA. Insulin initiates its physiological effects by binding to a high affinity specific receptor located on the plasma membrane. It is not altered during the binding process, and reaction of the disulfide bonds is not involved. After binding to the receptor, insulin transmits its signal to the interior of the cell through a second messenger that influences enzymatic processes. Thus, the hormone probably carries out its actions without entering the cell. Two membrane-bound enzyme systems are associated with the insulin signal: the adenyl cyclase-cAMP and the Mg-activated Na-K-ATPase systems. Insulin inhibits cAMP formation only in situations where it has been previously stimulated by catecholamines, glucagons, or other hormones. Stimulation of intracellular Potassium transport is one of the well-known effects of insulin. In turn, potassium is an important factor in membrane potential and enzymatic regulation. Magnesium is involved in the activation of many intracellular enzymes. Intracellular Magnesium accumulation is also promoted by insulin. It has been proposed that the insulin membrane receptor is located in the vicinity of the Magnesium-dependent Sodium-Potassium-ATPase system and that activation of the receptor modifies the activity of this system. The result is an accumulation of Magnesium intracellularly with activation of critical intracellular enzymes.

The ability of insulin to mediate tissue glucose uptake is a critical step in maintaining glucose homeostasis and in clearing the postprandial glucose load. The insulin production is directly proportional to the amount of sugar (carbohydrate) consumed. The more sugar one consumes, the more insulin the body will have to produce, but, the tiny pancreatic beta cells were never designed to produce this level of insulin. With a limited capacity to produce insulin, a capacity that is more than sufficient to last a lifetime under normal dietary conditions, the forced over-production of insulin will eventually exhaust that capacity and the cells will cease to operate. However, insulin production does not always depend on blood
glucose levels; insulin is stored in the cells prior to its release. Insulin deficiency plays a central role in all forms of diabetes because it is the major hormone that enables cells (primarily muscle and fat cells) to uptake glucose from the bloodstream. Insulin makes it possible for most body tissues to remove glucose from the blood for use as fuel, for conversion to other needed molecules, or for storage. Furthermore, insulin is also the major regulatory signal for glycogenesis in the hepatocytes and myocytes.\textsuperscript{[4]}

Higher insulin levels upregulate various anabolic processes, including cell growth, cellular protein synthesis, and fat storage. Insulin is more of an anabolic hormone rather than catabolic. Insufficient amounts of insulin or poor cellular response to insulin as well as defective insulin leads to improper handling of glucose by body cells or appropriate glucose storage in the liver and muscles. This ultimately leads to persistently high levels of blood glucose, poor protein synthesis, and other metabolic derangements.\textsuperscript{[4]} As a consequence of the widespread prevalence of diabetes and the severity of its complications, extensive research and treatment development efforts must be undertaken to identify and develop more effective remedies to improve the quality of life of those affected by the disease.\textsuperscript{[22]} The chronic hyperglycemia arising from diabetes mellitus accompanies long-term damage, dysfunction, and failure of various organs, especially the eyes, kidneys, nerves, heart, and blood vessels. Pathogenesis of diabetes mellitus underlies autoimmune destruction of the pancreatic beta cells, leading to insulin deficiency and biosignalling derangements that are consequent to insulin resistance or insensitivity. Defective insulin secretion and defective insulin action frequently coexist in the same patient. It is still obscure which abnormality is the primary cause of the hyperglycemia.\textsuperscript{[4]}

Hyperglycemia is characterized by polyuria, polydipsia, weight loss, sometimes with polyphagia, and blurred vision. Stunted growth and susceptibility to opportunistic infections may also be associated with chronic hyperglycemia. Uncontrolled diabetes mellitus leads to hyperglycemia with ketoacidosis as well as the nonketotic hyperosmolar syndrome. Long-term metabolic complications of diabetes mellitus include retinopathy, nephropathy, peripheral neuropathy, amputations, and Charcot joints as well as autonomic neuropathy causing gastrointestinal, genitourinary, cardiovascular symptoms and sexual dysfunction. Diabetics are also at a greater risk atherosclerotic, cardiovascular, peripheral arterial and cerebrovascular disease. Hypertension and abnormalities of lipoprotein metabolism also accompany uncontrolled diabetes mellitus. Insulin regulates blood glucose levels by its
effects on the liver and skeletal muscles. Normal blood glucose levels are maintained by sustenance of balance between hepatic glucose production and glucose utilization by the peripheral tissues. Insulin regulates hepatic gluconeogenesis and promotes glucose catabolism by the skeletal muscles. In type 2 diabetes mellitus, post absorptive hepatic glucose production is increased, which positively correlates with fasting plasma glucose concentration. Between gluconeogenesis and glycogenolysis, gluconeogenesis appears to be drastically increased in type 2 diabetes mellitus.\[^4\]

It is postulated that an enhanced release of gluconeogenic precursors is annexed to increased total glucose output. Unnecessary glucose output can be ameliorated by inhibition of glycogenolysis and/or gluconeogenesis from endogenous precursors. Stimulation of intrahepatic disposal of neoformed glucose contributes to autoregulation. These observations support the concept that intrahepatic disposal of glucose-6-phosphate plays a major role in the control of endogenous glucose production.\[^{23}\] One of the study, established that the degree of impaired beta-cell responsiveness to glucose is closely related to the degree of fasting hyperglycemia but in a curvilinear fashion. Decreased insulin secretion and defective cellular insulin action also compromise efficient glucose uptake by peripheral tissues. This derangement gets more predominant as the islet dysfunction declines. Management interventions improve islet function and raise plasma insulin levels, reduce hepatic gluconeogenesis, or improve the efficiency of tissue glucose uptake.\[^{24}\]

One of the study argues that even if fasting insulin levels are comparable between type 2 diabetics and normal subjects, insulin secretion is markedly impaired in type 2 diabetics in relation to the degree of hyperglycemia present. Furthermore, the degree of fasting hyperglycemia in a given patient with non-insulin-dependent diabetes mellitus is closely related to the degree of impaired pancreatic beta-cell responsiveness to glucose.\[^{25}\]

**ECONOMIC BURDEN**

Economic aspects of diabetes care currently attract considerable attention as the world diabetes epidemic takes hold and the healthcare activities of countries come under pressure to accomplish more within constrained resources.\[^{26}\] Diabetes mellitus is a very expensive disease and has profound implications in terms of long-term microvascular and macrovascular complications and their associated cost. These complications, reduce both life expectancy and quality of life.\[^{27-28}\]
The World Health Organization’s World Health Report in 2005 pointed out that 60% of the burden of diabetes and other chronic diseases occur in the low and middle income countries. It is only in the low income countries where the deaths attributable to communicable and non-communicable disease is similar in number and these countries struggle with a double burden of disease. In the middle income and upper income countries, non-communicable diseases are responsible for the largest burden of disease and far outweigh the burden of communicable diseases.\[5\]

In India, a recent study showed that total annual expenditure by patients on diabetes care was, on average, INR (Indian Rupee value) 10,000 (US $227) in urban areas and INR 6,260 (US $142) in rural areas. An increase of 113% was observed in the total expenditure between 1998 and 2005 in the urban population. Low-income groups spent a higher proportion of their income for diabetes care (34% and 27% for urban poor versus rural poor respectively) without subsidies. The medical costs incurred by a person with diabetes are two to fivefold higher than those incurred by people without diabetes. The average expenditure per patient per year would be a minimum of INR 4,500 (approximately US $120). Therefore, the estimated annual cost of diabetes care would be approximately 180,000 million rupees.\[10\]

In India, estimates suggest that 85-95% of all health care costs are borne by individuals and their families with household income. The lowest income groups bear the greatest burden, paying a larger proportion of household income toward diabetes care. Direct expenses consume 27-34% of household incomes of rural and urban poor people while the middle-to-high income groups in rural and urban areas consume 5.0-12.6% and 4.8-16.9% of income respectively on diabetes care. Year-on-year increases in this proportion are greater in impoverished groups, worsening with duration of diabetes, presence of complications, hospitalization, surgical therapy and glycemic control requiring insulin.\[29\]

Diabetes mellitus poses a big economic burden with regards to health system costs, indirect costs arising from losses occasioned by patient disability and premature mortality, time spent by family members accompanying patients when seeking care, and intangible costs in terms of psychological pain to the family and loved ones. The effectiveness of prevention and control of those illnesses relies largely on the performance of health systems, functions of leadership and governance; health workforce; medical products, vaccines and technologies; information; financing; and service delivery.\[30\]
MANAGEMENT

Management of lifestyle is apparently the cornerstone of diabetes mellitus management. It is recognized as being an essential part of diabetes and cardiovascular disease prevention. Meta-analyses demonstrate that lifestyle interventions, including diet and physical activity, led to a reduction in diabetes incidence in those at high risk. Modification of lifestyle programs has demonstrated encouraging improvement in risk factors for diabetes; however, the effect on diabetes incidence has not been reported.\(^4\) The dietary diabetes mellitus management is a complement of lifestyle management and it has a positive effect on long term health and quality of life. Dietary management aims at optimal metabolic control by establishing a balance between food intake, physical activity, and medication to avoid complications. In type 2 diabetes, the dietary objective is for improved glycemic and lipid levels and weight loss as appropriate.\(^11\) In spite of the underscored importance of lifestyle measures in diabetes therapy, most diabetics cannot escape the value of pharmacotherapy to achieve target glucose concentrations. Different oral hypoglycemics have been in use to aid in maintenance of blood glucose level at the requisite threshold in diabetics through distinct mechanisms.\(^31\) Sulfonylureas and the nonsulfonylurea secretagogues establish normoglycemia by upregulating endogenous insulin secretion; alpha-glucosidase inhibitors work by delaying intestinal carbohydrate absorption; thiazolidinediones (TZDs) maintain normoglycemia by enhancing insulin sensitivity primarily by increasing peripheral glucose disposal, and suppressing hepatic glucose production. Metformin works by decreasing hepatic gluconeogenesis while at times also increasing peripheral glucose mobilization and disposal. Synthetic insulin injections are also a therapy against type I diabetes mellitus. Despite many effective oral hypoglycemic agents available to manage type 2 diabetes, 5 to 10\% of the population with diabetes experience secondary failure. This bottleneck can be arrested if clinicians understand the limitations of some therapies currently in use. Secondary failure arises as a result of deteriorating beta cell function, poor compliance to treatment, weight gain, reduced exercise, dietary changes, or illness. A major drawback associated with hypoglycemic agents is that they are expensive and harbor adverse effects on patients.\(^32\)

Medications obtained from the plant have also found immense use in the management of diabetes mellitus. There is a new trend in the world to avoid the adverse effects associated with conventional hypoglycemic agents to turn to phytodrugs. Many plant species have been used to treat life-threatening diseases including diabetes mellitus. A World Health Organization (WHO) study shows that 80\% of the world population solely rely on medicinal
plants for their primary health care needs. This overreliance on antidiabetic medicinal plants has probably invoked scientists to bioassay these plants in an effort to elucidate more hypoglycemic medicinal plants. The antidiabetic potential of some medicinal plant extracts has been demonstrated in human and animal models of type II diabetes. However, more detailed research on the antidiabetic plants is inevitable to ameliorate the concerns of in vivo safety and efficacy.[33]

**FUTURE PERSPECTIVES**

Presently, the management of type 2 diabetes focuses on glucose control via lowering of blood glucose (fasting and postprandial) and hemoglobin A1c. The considered view is that the diabetes therapy should focus on delaying progression of the disease. Treatment options are supposed to be directed at the known pathogenetic disturbances of the disease. Currently, treatment and/or management strategies have been conducted on the development of novel therapeutic options that are more efficacious in maintaining normoglycemia in type 2 diabetics and that provide durable glucose control.[4,34] The realization that diabetes mellitus is a “metabolic curse” should be a trigger for desire to seek understanding of the biochemical and molecular basis of this metabolic disorder. Such an understanding will inform efforts to elucidate more effective management interventions against diabetes mellitus. In this regard, more efficacious synthetic insulin with rapid actions, ability to traverse all body compartments, less adverse effects as well as longer durations of actions need to be designed. The oral hypoglycemic agents, which are apparently bedeviled by side effects, need to be optimized to mitigate these demerits. Lifestyle management needs to be optimized to achieve the intended goal of lowering the glycemic index in diabetics. Gene therapy will doubtlessly address the complications of diabetes mellitus. The pioneering gene therapy approach to diabetes mellitus was occasioned by the cloning of the insulin gene. The strategy was based on the premise that non-insulin producing cells could be manipulated to produce insulin using a suitable promoter and insulin gene construct. It was thought that these substitute cells could reclaim insulin production diabetics. Advances in molecular biology have enabled unraveling of the human genome. This milestone can be exploited in order to characterize the insulin gene for its subsequent use in the diabetes management. The immunological concerns underlying gene therapy can also be addressed by the current advances in molecular biology. However, irrespective of all these concerns, it is imperative to always farthom that the merits of gene therapy of diabetes, exceed the demerits and present advantages as compared with
conventional treatment before this approach could gain widespread acceptance in general medical practice.\textsuperscript{[4]}

**CONCLUSION**
Diabetes mellitus is not a single disease but is a group of metabolic disorders affecting a huge number of population in the world. It is mainly characterized by chronic hyperglycemia, resulting from defects in insulin secretion or insulin action. Diabetes has already been described as an epidemic, but predictions for future increases in prevalence, especially in developing countries, point to a major health care crisis in the future. With an estimated 40 million people suffering from the condition in India, diabetes has become a major health care problem in India. The high costs of treatment of diabetes amongst all socioeconomic patient groups will result in a serious burden on both patients and country resources alike. This long term economic implications are worrying. There is an imminent need for urgent contextual research, immediate health policy restructuring and implementing inexpensive intervention with sincere efforts to mitigate the potentially catastrophic increase in diabetes that is predicted for the upcoming years.

**COMPETING INTERESTS**
The author declares that he has no competing interests.

**ACKNOWLEDGEMENTS**
The author expresses his sincere thanks to Professor S. Srivastava, Department of Genetics, University of Delhi South Campus, New Delhi, India for suggestion and guidance. The author gratefully acknowledges Dr. Manju, Shreya and Ishita for their valuable cooperation in the preparation of this review article.

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