STEM CELLTHERAPY IN DIABETES
(PG4)
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1. Diabetes is a metabolic disease characterized by increased glucose levels.

2. There are four types of diabetes: type 1, type 2, gestational, and other specific types.

3. Type 1 diabetes is caused by the autoimmune destruction of pancreatic β-cells.

4. Type 2 diabetes results from insulin resistance and impaired insulin secretion.

5. Gestational diabetes occurs in overweight and obese pregnant women.

6. Complications of diabetes include cardiovascular disease, stroke, amputation, and microvascular damage.

7. Diabetes has a significant impact on the prevalence of tuberculosis.

8. The number of diabetic patients is projected to increase worldwide.

9. Diabetes prevalence is rising rapidly in low and middle-income countries.

10. Diabetes has a significant economic burden on countries.

11. Current diabetes treatment relies on exogenous insulin injections and analogues.

12. Cell-based therapy, particularly stem cells, is a promising approach for diabetes treatment.

13. Stem cells have the potential to differentiate into insulin-producing β-cells.

14. Whole pancreas transplantation is a common treatment for diabetes.

15. Islet transplantation is a promising therapy but faces limitations due to the availability of grafts.

16. Embryonic stem cells (ESCs) have the highest differentiation potential.

17. Induced pluripotent stem cells (iPSCs) offer an alternative to ESCs and can be generated from a patient's own cells.

18. Mesenchymal stem cells (MSCs) derived from various tissues show potential for diabetes treatment.

19. Bone marrow-derived MSCs and adipose tissue-derived MSCs have shown positive results in insulin production.

20. MSCs offer pro-angiogenic and immunomodulatory properties, making them attractive for diabetes treatment.

Introduction:

- Diabetes mellitus is a metabolic disease characterized by increased glucose levels or hyperglycemia.
- Insulin secretion and its efficient functioning are crucial for maintaining glucose homeostasis.
- Diabetes is classified into four types: type 1 diabetes (T1D), type 2 diabetes (T2D), gestational diabetes, and other specific types.
- T1D is caused by the autoimmune destruction of pancreatic β-cells, leading to a complete loss of insulin.
- T2D results from insulin resistance and impaired insulin secretion.
- Complications of diabetes include acute conditions like ketoacidosis and long-term complications such as cardiovascular disease, retinopathy, nephropathy, and neuropathy.
- Diabetes has a significant impact on the prevalence of tuberculosis.

Comparison of Type 1 Diabetes and Type 2 Diabetes

	Type 1 Diabetes	**Type 2 Diabetes**
Occurrence	Onset in childhood (under 20)	Onset in later stage of life (after 40)
Prevalence	Less prevalent (5-10%)	More prevalent (80-85%)
Risk factors	Genetic factors	Genetic factors, Life style and environmental factors
Appearance		
-Phenotype	Auto-immune destruction of beta-cells	Defect in insulin signalling pathway with impaired insulin secretion
	Absolute insulin deficiency	Insulin resistance and deficiency
	Exogenous insulin is strictly required	Exogenous insulin is required
	Susceptible to ketoacidosis	No ketoacidosis
-Genotype	Associated with HLA	Not associated with HLA
	More than 50% identical twins are susceptible to T1D	More than 70% identical twins are susceptible to T2D
Treatment	Insulin injections	1-Healthy diet and physical exercise 2-Insulin injections

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Prevalence of Diabetes:

- The number of diabetic patients worldwide is projected to increase from 415 million in 2015 to 642 million by 2040.
- Diabetes prevalence is rising rapidly in low and middle-income countries, particularly in the South-East Asia region.
- Diabetes poses a financial burden on countries, with healthcare expenditures ranging from 5% to 20% of total health expenditure.

Treatment and Therapy Approaches:

- Diabetes-related deaths are estimated to be around 3.7 million per year, making it a leading cause of death.
- Current treatment methods rely on exogenous insulin injections and various analogues to manage blood glucose levels.
- Cell-based therapy, primarily through pancreas or islet β-cell transplantation, is a common approach.

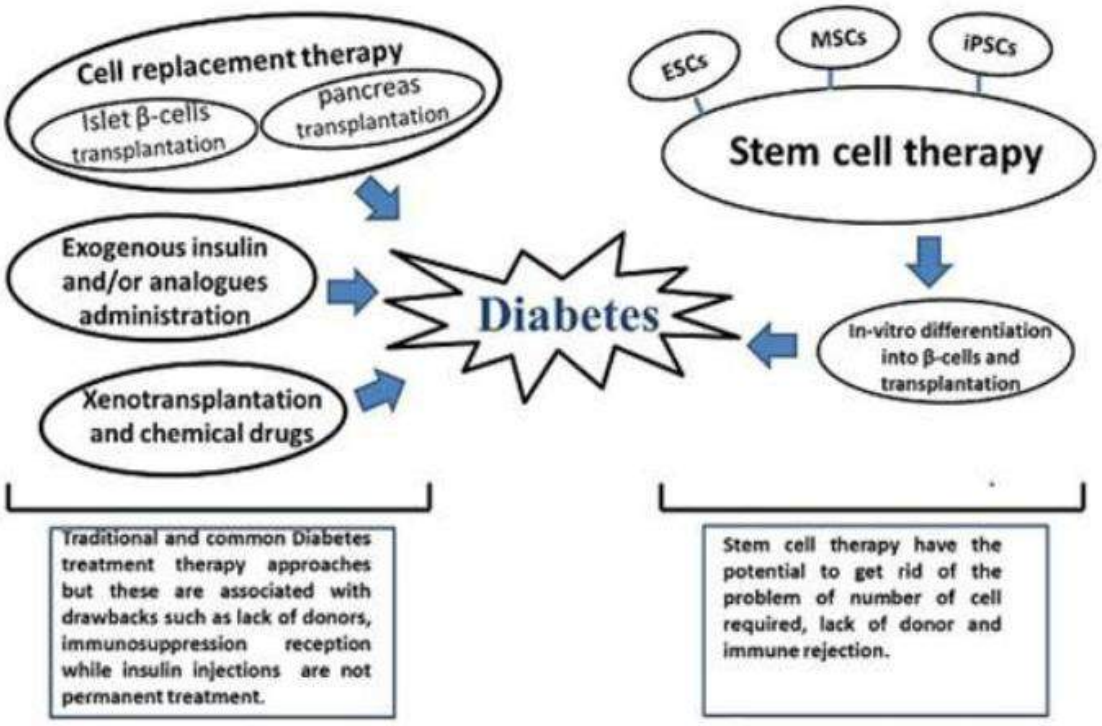

Figure 2. Current treatment and therapy approaches of Diabetes.

- Stem cells have the potential to differentiate into pancreatic β-cells, offering an alternative in diabetes treatment.

- Different types of stem cells used in diabetes therapy include embryonic stem cells (ESCs), mesenchymal stem cells (MSCs), hematopoietic stem cells (HSCs), induced pluripotent stem cells (iPSCs), and adult stem cells derived from adult tissues (ASCs).

Whole Pancreas Transplant and Pancreatic Islet Transplantation:

- Whole pancreas transplantation involves grafting a viable pancreas from a deceased donor to replace the diseased islet β-cells.
- While it rapidly reverses hyperglycemia, whole pancreas transplantation requires lifelong immunosuppression and has associated morbidity.
- Pancreatic islet transplantation involves isolating and purifying islets from the pancreas for transplantation.
- However, the limited availability of islet grafts containing insulin-producing β-cells remains a major challenge.

Stem Cells as an Alternative:

- Stem cells have unique features like self-renewal and the ability to differentiate into various cell types.
- Embryonic stem cells (ESCs) have the highest differentiation potential but face ethical issues.
- Induced pluripotent stem cells (iPSCs) can be generated from a patient's own somatic cells, eliminating the risk of immune rejection.
- Mesenchymal stem cells (MSCs) derived from various tissues show promise in diabetes treatment due to their proliferative capacity and immunomodulatory properties.
- Studies have demonstrated the differentiation of MSCs into insulin-producing β-cells, offering a potential therapy for diabetes.

Conclusion:

- Stem cells hold promise in diabetes cell-based therapy as an alternative to conventional treatments.
- Different types of stem cells, including ESCs, iPSCs, and MSCs, have shown the ability to differentiate into insulin-producing β-cells.
- The use of stem cells could overcome the limitations of current treatment approaches and provide better outcomes for patients with diabetes.

Existing treatment therapies of diabetes suffer from various drawbacks which insist the researchers to establish an alternative to these therapy approaches. Enormous research work done so far in the area of β-cells differentiation from stem cells and further transplantation of these stem cells derived pancreatic β-

cells into diabetic model organism provides new opportunity to cure the diabetes. With all this, stem cell based diabetes therapy has advantages over existing cell replacement therapy. Despite the achievements and advantages of stem cells in diabetes therapeutics, some limiting factors like safety concern, teratoma formation and ethical issues of ESCs prevent the proper exploration of stem cells in clinical trials. The recent advancements in the stem cell research field has enabled the researchers to generate the insulin producing β-cells from stem cells. Therefore, stem cell therapies may offer excellent opportunity towards treatment of diabetes.