

## Treating Diabetes with Stem Cells

Siniša Franjić

**Citation:** Franjić S. Treating Diabetes with Stem Cells. *J Cell Sci Regenerative Med* 2025; 1(3): 109-113.

**Received:** 27 June, 2025; **Accepted:** 09 July, 2025; **Published:** 11 July, 2025

**\*Corresponding author:** Siniša Franjić, Independent Researcher, E-mail: [sinisa.franjic@gmail.com](mailto:sinisa.franjic@gmail.com)

**Copyright:** © 2025 Franjić S, et al., This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

### ABSTRACT

Type 1 diabetes is an exceptionally serious illness that happens as of now in childhood, and is caused by the failure of the pancreas to emit affront. The patient's safe framework assaults the parts of the pancreas that are mindful for affront discharge and devastates them, driving to affront insufficiency and diabetes. Stem cell treatments are getting to be more and more curiously and available to the world of medication, which is why modern revelations and accomplishments are distributed each day.

**Keywords:** T1D, T2D, DM, Stem Cells, MSC, Health

### 1. Introduction

Diabetes Mellitus is a metabolic disorder characterized by a tall blood sugar level (hyperglycemia) over a delayed period<sup>1</sup>. The three fundamental sorts of diabetes incorporate type 1, type 2, and gestational diabetes. As such type 1 diabetes is a constant deep rooted condition characterized by the failure of the body to break down sugar and carbohydrates coming about from the failure of pancreatic beta cells to create sufficient affront. Whereas type 2 diabetes mellitus is moreover known as affront cold-heartedness or non-insulin subordinate diabetes mellitus, is a type of complex metabolic disorder connected to vitality digestion system, commonly related with fat and carbohydrate digestion system. As an person gets to be corpulent, they enter a more insulin-resistant state coming about in impeded glucose resilience, which is the forerunner to type 2 diabetes. Gestational diabetes in the other hand is a frame of diabetes that happens during pregnancy, commonly related with the failure of the body to emit satisfactory sums of affront to compensate for pregnancy-induced affront resistance.

Since type 1 diabetes includes the pancreatic cells which is a visceral organ, regulating MSCs (Mesenchymal stem cell) through neighborhood and systemic approach can be of a challenge. As such the supply routes providing the pancreas emerges from the celiac trunk which is a department of the stomach aorta. Subsequently intravenous approach appears to be the best systemic approach in tending to this were MSCs

can be conveyed through the femoral, cephalic, basilic or cubital veins which carries the MSCs back to the heart and lungs to be oxygenated. After that, MSCs will be conveyed all through the body by means of the supply routes. Due to that, we accepted higher dosage of MSCs is required to accomplish the restorative impact by recovering the b-cells in the Islets of Langerhans in the pancreas. Such approach was comparative to the b-cell substitution treatment presented in 1972, in which islet transplantation were done through the entry veins. In any case, the entrance vein is not effectively available. Moreover, it is uncertain if high-impact preparing can be advantageous in this situation, as one may proposed where oxygen consuming preparing increments the heart rate and stroke volume which increments the circulation where MSCs can be conveyed to the pancreas. In the opposite, as the law of autonomic anxious framework applies, thoughtful enactment increments the blood supply to the strong framework whereas parasympathetic enactment increments the blood supply to the stomach related framework. Consequently, unwinding work out ought to be more reasonable for this scenario.

As for type II diabetes mellitus umbilical cord-derived MSCs had been detailed to improve affront resistance by smothering NLRP3 inflammasome-mediated irritation in type 2 diabetes rats which is related with affront resistance. Physical works out and action in the other hand increments skeletal muscle glucose take-up, makes strides mitochondrial biogenesis and work,

and increments the expression of glucose transporter proteins and various metabolic qualities. Since affront resistance is progressively considered to be related with systemic unremitting aggravation where hoisted levels of tumor necrosis factor (TNF)- $\alpha$  and interleukin (IL)-1 $\beta$  in blood is seen as prescient pointers of the advancement of sort II diabetes, physical exercise in this setting is to combat obesity which progresses the blood glucose control in type 2 diabetes, at the same time MSCs may stifle those fiery markers related to type 2 diabetes. Moreover, collecting adipose determined MSCs through liposuction moreover decreases the fat rate. Additionally, the collected cells can be readministered into the individual's body in treating type 2 diabetes. Physical works out in the other hand anticipates obesity and subsequently decreases the chance of type 2 diabetes.

## 2. T1D

Type 1 diabetes mellitus (T1D) includes the immune system devastation of the islets of Langerhans, which are dependable for the endocrine work of the pancreas [2]. Islets comprise of  $\alpha$ - and  $\beta$ -cells, which react to their local environment and are dependable for energetic, responsive glycemic control. In straightforward terms, when blood sugar is as well tall (i.e., hyperglycemia), affront is discharged from  $\beta$ -cells to diminish blood glucose. When blood glucose is as well low (hypoglycemia), glucagon is discharged from  $\alpha$ -cells to increment blood sugar. In this way, islets contribute toward body homeostasis and accomplish euglycemia (i.e., a glucose level from 3.9 to 10 mmol/L), physiologically quickly responsive, in any case of their glucose admissions. Subsequently, in patients with T1D, without islets to encourage glycemic control, both hyperglycemia and hypoglycemia can happen, driving to substantive results in both states. With hyperglycemia, patients involvement expanded urination (i.e., polyuria), thirst (i.e., polydipsia), nausea, vomiting, abdominal pain, fatigue, and fruity-smelling breath. Physiologically, diabetic ketoacidosis (DKA) can happen when the body falls flat to utilize vitality sources suitably and moves into a catabolic state to produce non-glucose-sourced vitality. DKA quickly gets to be a life-threatening condition due to expanding parchedness, acidosis, and perplexity, with a mortality rate of 0.3–1.3%. Chronically, hyperglycemia leads to noteworthy microvascular and macrovascular complications that definitely decrease the quality and amount of life, counting coronary artery disease, fringe vascular infection, neuropathy, nephropathy, and retinopathy. On the other hand, hypoglycemia leads to prompt autonomic and neuroglycopenic complications, counting trembling, drowsiness, vision and speech issues, palpitations, anxiety, and most concerning, loss of consciousness (i.e., diabetic coma), and death. Chronically, hypoglycemia can lead to patients losing mindfulness of these occasions (i.e., hypoglycemic ignorance) and confers a significant dreariness and mortality chance in patients with T1D.

## 3. T2D

The dreariness and mortality of diabetes mellitus (DM) are not limited to those with T1D [2]. More than 400 million patients around the world are analyzed with type 2 DM (T2D) and involvement significant impacts from hyper and hypoglycemia. Patients with T2D encounter glycemic changeability since of lacking affront discharge, relative tissue affront resistance, and destitute compensatory affront emission. Whereas these patients do not encounter an outright need of islets, the long-term metabolic results stay comparable. Patients with T2D

involvement comparative hyper and hypoglycemia indications and complications. Most patients with T2D are treated with verbal treatments. Verbal specialists increment the physiologic affront generation from remainder islets or progress the affront affectability of fringe tissues. When verbal specialists are lacking due to compounding affront resistance or assist utilitarian islet misfortune, affront is presented. About 15% of patients with T2D require affront treatment, a extent that is proceeding to develop. Current medicines point to increment affront work in any case of the treatment, verbal operator, or affront. Subsequently, islet transplantation (ITx) might give a comparative result in these patients; be that as it may, ITx is seldom connected these days for patients with T2D due to the hazard related with life-long immunosuppression and since of effectively available verbal treatments. In spite of these current restrictions, as talked about underneath, optimizing ITx procedures may kill immunosuppression necessities and open the entryway for ITx in patients with T2D. This encourage highlights the require to optimize versatility amid advancement forms, as the number of patients who may advantage from these approaches distant surpasses as it were patients with T1D.

## 4. Types of Cells

Some types of cells can partition indeed in spite of the fact that completely separated, permitting for recharging and recovery without the utilize of stem cells<sup>2</sup>. The insulin-secreting pancreatic  $\beta$  cells are one illustration. Their mode of reestablishment has a extraordinary significance, since it is their misfortune through immune system assault that is capable for type 1 (juvenile-onset) diabetes, and their useful decrease with age and obesity is moreover a noteworthy figure in type 2 (adult-onset) diabetes. The  $\beta$  cells are ordinarily sequestered in cell clusters called islets of Langerhans. The islets appear not to contain stem cells, however modern  $\beta$  cells are persistently produced inside the islets. Heredity following ponders, comparable to those portrayed prior, appear that the recharging of this populace ordinarily happens by the straightforward division of separated insulin-producing  $\beta$  cells.

Another tissue that can reestablish by straightforward division of completely separated cells is the liver. The fundamental cell sort in the liver is the hepatocyte, a expansive cell that performs the liver's numerous metabolic capacities. Hepatocytes ordinarily live for a year or more and separate at a exceptionally moderate rate. Effective homeostatic components work to alter both their rate of cell multiplication and their rate of cell passing, to keep the liver at its ordinary estimate and to reestablish that measure in the case of harm. A emotional impact is seen if expansive numbers of hepatocytes are evacuated surgically or murdered by harming with carbon tetrachloride. Inside a day or so after either sort of harm, a surge of cell division happens among the surviving hepatocytes, rapidly supplanting the misplaced tissue. If two-thirds of a rat's liver is expelled, for case, a liver of about typical estimate can recover by hepatocyte expansion inside almost 2 weeks.

Both the pancreas and the liver moreover contain little populaces of stem cells that can be called into play as a reinforcement instrument to deliver the separated cell sorts in more extraordinary circumstances.

## 5. The Cure

Diabetes mellitus (DM) is one of the most widespread

unremitting illnesses that win around the world, and the predominance has proceeded to be developing in later decades<sup>3</sup>. The patients with DM show a hyperglycemic state initiated by impedances in affront discharge (type 1 and at the late stage of type 2), affront affectability (type 2), or both. Type 1 diabetes mellitus (T1DM), which accounts for less than 10% of patients with DM, happens through components of an immune-mediated harm and devastation of pancreatic beta cells in the pancreatic islets of Langerhans, driving to supreme affront lack. Type 2 diabetes mellitus (T2DM), which accounts for more than 90% of patients with DM, is characterized by affront resistance in fringe tissues and relative affront lack. At first, patients with T2DM do not require affront treatment; in any case as populace and work of pancreatic beta cells decreases over time, in the long run exogenous affront supplementation will be required at a late stage. DM is frequently complicated with major organ harm such as retinopathy, nephropathy, and neuropathy, as well as macrovascular diseases counting coronary, cerebral, or fringe vascular atherosclerosis.

The remedy of DM depends on recovering useful beta cells, reestablishing affront discharge, and calming irregular autoimmunity. Allologous entirety pancreas or islet transplant has been utilized to treat DM. The information from the International Pancreatic Transplant Registry appeared promising comes about that clinical hyperglycemia was quickly controlled in the beneficiaries after transplantation, with considerably ceased supplementation of exogenous affront. In any case, its clinical application is altogether restricted by the need of organ benefactors, tall chance of major surgery compilations, and the require for long lasting immunosuppressive treatment to anticipate graft rejection. In terms of these restrictions, as of now the allologous entirety pancreas or islet transplant is as it were prescribed to insulin-dependent diabetic patients with end-stage renal illness who require kidney co- transplant. Accomplishment of the remedy of DM requests more useful and attainable methods.

Stem cells, characterized by the potential of multi-lineage separation and self-renewal, have illustrated their special parts in useful insulin-producing cell (IPC) recovery, safe tweak, and other areas of regenerative considers. Compared to organ or tissue transplant, stem cell treatment has the taking after points of interest in the treatment of DM. Autologous stem cells can suit a long-term steady source and are not constrained by the source of givers. Stem cells are also able to mystery various cytokines, balance the local inflammation of pancreatic islets, and assist move forward the microenvironment and autoimmunity. In addition, stem cell-derived IPCs can maintain a strategic distance from unite dismissal and dispense with the need of immunosuppressive treatment. Tentatively, novel endeavors to renew pancreatic beta cells in DM, with extraordinary respect to IPCs for transplant purposes, seem be substituted beta cells by allo- or autografted stem cells. Therefore, we checked on and talked about the later progresses in stem cell treatment for DM in endeavor to clarify where we are and how we may go to reach the last objective of the cure of DM.

## 6. ITx

In trusts of accomplishing optimized glycemic control by giving patients with energetic, physiologic glycemic control, transplant analysts have created strategies to reestablish islet

mass, counting entire pancreas transplant and ITx<sup>4</sup>. Both procedures have appeared guarantee, each with its benefits and disadvantages. Whereas a pancreas transplant offers total rebuilding of endocrine work, the strategy and post-operative immunosuppression bestow chance to patients. On the other hand, ITx has restricted perioperative complications but moreover remains constrained due to immunosuppression necessities, and in some cases comes up short to give endocrine work due to small accessible islet mass, compounded by resistant annihilation. Assist, both methods are restricted by benefactor supply and, subsequently, cannot meet the needs of >400 million patients with DM. Since of these confinements and to optimize pancreas giver assignment, particular signs have been developed to portray who ought to get each of these approaches. For ITx, as it were patients with extreme hypoglycemia, hypoglycemic ignorance, or delicate T1D with substantive glycemic abnormality are right now candidates.

Stem cell-derived ITx offers an unparalleled opportunity to dispose of giver supply impediments and immunosuppression and make strides ITx results. This would empower thought of a more fabulous persistent statistic for transplant, counting those with T2D. In this approach, stem cells (SCs), counting actuated pluripotent stem cells (iPSCs), are guided through separation to deliver expansive numbers of islets for ITx. Right now, investigate to optimize these forms and clinical trials assessing their adequacy in people are underway and appearing promising preparatory comes about. Utilizing these approaches, the trust is to give a potential remedy for DM that can be accessible broadly to all influenced patients. Whereas current perished benefactor allogeneic ITx hones have appeared surprising victory, they moreover stay constrained to patients with T1D due to the related dangers of long lasting immunosuppression. Be that as it may, utilizing SC-derived ITx with the potential for immunosuppression-free transplant, the opportunity to treat all patients with diabetes, counting those with T2D, is conceivable. Autologous or immune-protected SC-derived ITx may offer the best comes about to those patients, as the potential for repetitive immune system assault won't affect their islet unites. Hence, the point of SC-derived ITx isn't fair to remedy roughly 4 million patients with T1D but to possibly remedy >400 million patients living with all shapes of DM.

## 7. AI

The to begin with step to autologous SC-derived ITx includes creating an individualized patient-specific iPSC line<sup>4</sup>. To accomplish this, substantial tissues (frequently PBMCs) are collected and extended in vitro. Once an satisfactory number of cells are developed, cells are at that point refined with the Sendai infection, which empowers the expression of Yamanaka components and the improvement of iPSCs. Sendai infection transduction productively conveys transgenes to beneficiary cells without genomic integration. In spite of being the most proficient strategy, as it were 1-3% of PBMCs (Peripheral blood mononuclear cells) effectively gotten to be iPSCs. Furthermore, cells must be passaged roughly ten times for the Sendai infection to be imperceptible in reconstructed cells. Hence, once cells are transfected, colonies must be chosen, passaged up to ten times, and at that point characterized to decide the ideal iPSC clone. Each colony is chosen physically based on its morphology and exchanged to a culture dish for extension as a interesting clone. Once clones have been passaged roughly ten times and reach



satisfactory intersection (i.e., development over 2 to 4 weeks), each clone must experience total characterization, counting stream cytometry, hereditary investigation, viral screening, and RNA sequencing. Utilizing these characteristics, an ideal clone, with the best expression of pluripotency markers and without viral disease or hereditary move, is chosen as the last quiet iPSC line. Cells from the ideal clone at that point require advance development until an satisfactory number is accessible for separation, once more taking roughly 1 to 2 weeks. At long last, the extended iPSC line experiences a 27-day separation convention to produce islets for transplant. Some time recently the transplant, those cells experience re-characterization to assess separation victory and off-target development and guarantee item security. The prepare takes roughly 2 months, with cell support, assessment, and separation activities required about daily.

Currently, iPSC era and separation are completed physically. Be that as it may, particular morphologic and development motor cellular characteristics empower the computerized choice of ideal PBMCs for iPSC era. So also, the ideal iPSC clone may be chosen with robotized innovation. Our lab has appeared the capacity to recognize, track, and select ideal iPSC clones utilizing artificial intelligence (AI) innovation. Counterfeit insights (AI) can learn characteristic morphologic and development highlights of iPSCs to permit ideal clonal selection.

In expansion to selecting ideal iPSC lines for autologous ITx approaches, mechanized AI-directed innovation too offers benefits to ESC-derived allogeneic ITx. Whereas allogeneic approaches for SC-derived ITx don't confront the challenge of creating pluripotent lines, they require cell upkeep and development. If a single adjusted ESC (Embryonic stem cell) is utilized for all patients, that line must be developed, kept up in culture, and extended some time recently separation. Whereas mechanized frameworks have appeared the capacity to select ideal iPSC lines, they can moreover grow cells. Subsequently, applying procedures and innovation comparative to these may be utilized to keep up and grow ESCs to make strides the versatility of allogeneic SC-derived ITx approaches. These approaches are likely to keep up more reliable cell lines and decrease every day manual cell upkeep costs, hence progressing the potential for allogeneic SC-derived ITx.

## 8. Stem Cell Therapy

There is a developing worldwide intrigued in stem cells investigate and the plausibility to utilize it for treating different infections such as diabetes<sup>5</sup>. Stem cells have awesome restorative potential in this field. They have the potential for self-renewing, repairing harmed tissues cells, immunomodulatory properties, and their capacity to give an boundless source of insulin-producing  $\beta$ -cells. The to begin with human clinical trial utilized autologous nonmyeloablative hematopoietic stem cells transplantation (AHST) to treat recent type 1 diabetic (T1D) patients. Moreover, it was assessed the security and metabolic impacts of immunosuppression treatment. The comes about appeared that most recently T1D patients finished distinctive times of affront autonomy and treatment-related poisonous quality was satisfactory, no mortality detailed. In addition, with AHST,  $\beta$ -cell work was made strides promisingly. In any case, this consider needs assist follow-up to affirm the time of affront autonomy, haphazardness test, and a control group. A clinical ponder was carried out to appraise the impacts of AHST

in clinical and atomic forms in 9 recent T1D patients. The comes about appeared that AHST expanded the islet cell work due to expulsion of the islet particular autoreactive T cells; the distinction in T1D persistent responses to AHST may be alluded to these diverse transcriptional activities in the fringe blood mononuclear cell. In spite of the fact that less clinical trials have been performed in creating stem cell treatment for T2D, a few empowering comes about have been detailed. It was examined the combination of intrapancreatic autologous stem cell (ASC) implantation with hyperbaric oxygen treatment (HBOT) in 25 T2D patients. In the follow-up period, hemoglobin A1c (glycosylated hemoglobin) levels were diminished, the affront dosage necessities diminished and expanded C-peptide levels. These comes about propose that ASC implantation and HBOT have positive helpful impacts for T2D patients by progressing metabolic control and decreasing affront prerequisites. Be that as it may, this consider requires randomized controlled tests to affirm it. Another ponder that assessed the combination of autologous bone marrow stem cell transplantation (ABMSCT) and (HBOT) on 31 T2D patients. Critical diminishments in the dosage of verbal hypoglycemic drugs and diminished exogenous affront measurements have been illustrated in all patients who utilized this treatment, but the utilitarian improvement of pancreatic  $\beta$ -cell may be transitory. The intra-arterial infusion of stem cells determined from bone marrow to T2D patients appeared positive comes about, which affirm the adequacy and security of this treatment for diabetics. An case of current human clinical trial which utilized stem cells in diabetes treatment was a pilot ponder of the helpful possibility of educator stem cells treatment in T1D stage 1 for both sexes (18 years and older) in Hackensack, US. The point of this consider was to accomplish patient's apheresis and at that point have their possess blood returned to them with the "educated" lymphocytes. It was found that the stem cell teacher treatment can create the clinical treatment of diabetes and other infections by line blood-derived multipotent stem cells (CB-SCs) safe instruction and safe adjust acceptance without the moral and security issues related with conventional stem cell methods.

## 9. Conclusion

Diabetes is an autoimmune and chronic metabolic disease caused by the destruction of the beta cells of the islets of Langerhans in the pancreas, which eventually causes affront lack and misfortune of control over blood glucose levels. All as well regularly, individuals do not think almost their blood sugar levels some time recently getting a charge out of a scrumptious feast or a delicious dessert. In any case, for patients with type 1 diabetes, each diminutive and each activity is connected to readings from a glucometer, a gadget for measuring blood sugar levels. Beneath ordinary conditions, the pancreas contains beta cells that create affront to keep up typical blood sugar levels. Tragically, the resistant framework of type 1 diabetics crushes its claim beta cells and hence decreases or totally anticipates the generation of affront and hence the direction of blood sugar levels. Incessant tall blood sugar can cause blindness, nerve damage, kidney failure, heart disease, stroke and even death.

## 10. References

1. Gan QF, Leong PP, Cheong SK, et al. Incorporating Stem Cells Into Physical Rehabilitation in Rezaei, N. (ed): Comprehensive Hematology and Stem Cell Research. Stem Cell Therapy and Regenerative Medicine, 2024;4: 425.

2. Alberts B, Heald R, Johnson A, et al. Molecular Biology of the Cell, Seventh Edition. WW Norton & Company, 2022: 1289.
3. Lei L, Mao Y. New Advances in Stem Cell Therapy for Diabetes Mellitus in Pham PV. (ed): Pancreas, Kidney and Skin Regeneration. Springer International Publishing AG, 2017: 89-90.
4. Verhoeff K, Shapiro AMJ. Scaling Stem Cells to Cure Millions of Patients with Diabetes: Approaches, Technology, and Future Directions in Haider KH. Handbook of Stem Cell Applications. Springer Nature Singapore Pte Ltd., 2024: 460-469.
5. Balahmar RM. Differentiation of Stem Cells into Pancreatic Lineage: In vitro Cell Culture, in vivo Transplantation in Animal Models in Khan FA. (ed): Advances in Application of Stem Cells - From Bench to Clinics. Humana Press, Springer Nature Switzerland AG, 2021: 179-180.