In another example the phenotype may comprise an immunophenotype in which the expression of CD surface markers may be substantially unchanged after transfection.

[0016] In another example of any of the MSC or MSCs described herein, the transfected MSC or MSCs may be plastic-adherent, may express CD105, CD73, and CD90 (>95%), may lack expression of CD45, CD34, CD14, and HLA-DR surface molecules (<2%), and may be capable of differentiating into osteoblasts, adipocytes, and chondroblasts *in vitro*, satisfying the immunophenotype criteria defined by the International Society for Cellular Therapy (ISCT). In another example, the transfected MSC or MSCs may be undifferentiated.

[0017] In another example of any of the MSC or MSCs described herein, the MSC or MSCs may be in a cryopreserved state.

[0018] In another example, the MSC or MSCs may be for use in treating cancer. In certain examples, the cancer may comprise lymphoma, clear cell carcinoma, glioblastoma, temozolomide resistant glioblastoma, perianal carcinoma, oral melanoma, thyroid carcinoma, soft tissue carcinoma, cancer ulceration, nasal tumor, or gastrointestinal cancer, or any combination thereof. In another example, the MSC or MSCs may be for use in combination with 5FC, 5FU, GCV, or any combination thereof.

[0018a] In another example, the present disclosure refers to use of the MSC or MSCs as disclosed herein, in the manufacture of a medicament for treating cancer, for example lymphoma, clear cell carcinoma, glioblastoma, temozolomide resistant glioblastoma, perianal carcinoma, oral melanoma, thyroid carcinoma, soft tissue carcinoma, cancer ulceration, nasal tumor, or gastrointestinal cancer.

[0018b] In another example, the present disclosure refers to the MSC or MSCs as disclosed herein for use as a medicament.

[0019] In another example, the present disclosure refers to a method for transfecting mesenchymal stem cells (MSCs) with a nucleic acid construct from which one or more functional genes are expressed, the method comprising: exposing the MSCs to a transfection mixture comprising the nucleic acid construct which is complexed with a cationic polymer; exposing the MSCs to a first agent capable of redirecting endocytosed nucleic acids from intracellular acidic compartments and a second agent capable of stabilizing a microtubular network of the MSCs; and incubating the MSCs; thereby providing MSCs transfected with the nucleic acid construct.

[0019a] In one aspect, the present disclosure refers to a method for transfecting mesenchymal stem cells (MSCs) with a nucleic acid construct from which one or more functional genes are expressed, the method comprising:

exposing the MSCs to a transfection mixture comprising the nucleic acid construct which is complexed with a cationic polymer;

exposing the MSCs to a first agent capable of redirecting endocytosed nucleic acids from intracellular acidic compartments and a second agent capable of stabilizing a microtubular network of the MSCs; and

incubating the MSCs;

wherein the MSCs are not centrifuged during exposure to the transfection mixture, to the first agent and second agent, during incubation, or any combination thereof;

wherein the first agent comprises a fusogenic lipid, wherein the fusogenic lipid is selected from a group consisting of DOPE, CHEMS, DPPC, DOPC, and combinations thereof;

wherein the second agent a histone deacetylase inhibitor (HDACi);

wherein the cationic polymer is linear polyethylenimine (LPEI);

thereby providing MSCs transfected with the nucleic acid construct.

[0020] In another example of and of the method or methods described herein the MSCs may not be centrifuged during exposure to the transfection mixture, to the first agent and second agent, during incubation, or any combination thereof. In another example the step of incubating the MSCs may comprise gentle mixing without centrifugation. In another example the step of incubating the MSCs may comprise incubating the MSCs for at least

[0048] In another example there is provided herein a kit for transfecting a mesenchymal stem cell (MSC) with a nucleic acid construct from which one or more functional genes are transiently expressed, wherein the kit may comprise any one or more of: an MSC; a nucleic acid construct designed for transient expression of one or more functional genes; a cell culture media; a cationic polymer; a first agent capable of redirecting endocytosed nucleic acids from intracellular acidic compartments; a second agent capable of stabilizing a microtubular network of the MSC; instructions for performing any of the method or methods described herein; 5FC; GCV; and/or 5FU. In certain examples, the kit may comprise a cryopreservation buffer or agent, a thawing buffer or agent, or both, as described above.

[0049] In another aspect, the present disclosure refers to a method for transfecting mesenchymal stem cells (MSCs) with a nucleic acid construct from which one or more functional genes are expressed, the method comprising: culturing the MSCs in a growth medium; adding a transfection mixture comprising the nucleic acid construct which is complexed with a cationic polymer to the MSCs without removing the growth medium from the MSCs; adding a first agent capable of redirecting endocytosed nucleic acids from intracellular acidic compartments and a second agent capable of stabilizing a microtubular network of the MSCs to the MSCs; and incubating the MSCs while in contact with all of the transfection mixture, the first agent, and the second agent for an incubation period; wherein the first and second agents are added to the MSCs simultaneously with the addition of the transfection mixture, sequentially with the addition of the transfection mixture, or in combination with the transfection mixture; and wherein the MSCs are not centrifuged between the adding of the transfection mixture and expiry of the incubation period; wherein the first agent comprises a fusogenic lipid, wherein the fusogenic lipid is selected from a group consisting of DOPE, CHEMS, DPPC, DOPC, and combinations thereof; wherein the second agent a histone deacetylase inhibitor (HDACi); wherein the cationic polymer is linear polyethylenimine (LPEI); thereby providing MSCs transfected with the nucleic acid construct.

[0050] In another example of the method or methods for transfecting mesenchymal stem cells (MSCs) with a nucleic acid construct from which one or more functional genes are expressed as described herein, the incubation period may be at least about 2 hours. In another example, the incubation period may be about 2 hours, about 3 hours, about 4 hours, about 5 hours, about 6 hours, about 7 hours, about 8 hours, about 9 hours, about 10 hours, about 11 hours, about 12 hours, about 13 hours, about 14 hours, about 15 hours, about 16 hours, about 17 hours, about 18 hours, about 19 hours, about 20 hours, about 21 hours, about 22 hours, about 23

WHAT IS CLAIMED IS:

1. A method for transfecting mesenchymal stem cells (MSCs) with a nucleic acid construct from which one or more functional genes are expressed, the method comprising:

exposing the MSCs to a transfection mixture comprising the nucleic acid construct which is complexed with a cationic polymer;

exposing the MSCs to a first agent capable of redirecting endocytosed nucleic acids from intracellular acidic compartments and a second agent capable of stabilizing a microtubular network of the MSCs; and

incubating the MSCs;

wherein the MSCs are not centrifuged during exposure to the transfection mixture, to the first agent and second agent, during incubation, or any combination thereof;

wherein the first agent comprises a fusogenic lipid, wherein the fusogenic lipid is selected from a group consisting of DOPE, CHEMS, DPPC, DOPC, and combinations thereof;

wherein the second agent is a histone deacetylase inhibitor (HDACi);

wherein the cationic polymer is linear polyethylenimine (LPEI);

thereby providing MSCs transfected with the nucleic acid construct.

2. The method of claim 1,

wherein optionally the step of incubating the MSCs comprises incubating the MSCs for 2 hours to 48 hours;

wherein optionally the one or more functional genes comprise a suicide gene;

wherein optionally the one or more functional genes comprise Cytosine Deaminase (CDy), uracil phosphoribosyltransferase (UPRT), or both;

wherein optionally the transfected MSCs are each transfected with an average of at least 1000, at least 2000, at least 3000, at least 4000, at least 5000, at least 6000, at least 7000, at least 8000, at least 9000, or at least 10000 copies of the nucleic acid construct;

wherein optionally a multipotent phenotype of the transfected MSCs is substantially unchanged by the transfection,

wherein optionally the multipotent phenotype comprises tumor and/or cancer tropism properties of the MSC; and

wherein optionally the multipotent phenotype comprises an immunophenotype in which the expression of CD surface markers is substantially unchanged after transfection, preferably wherein the transfected MSCs are plastic-adherent, wherein >95% of the transfected MSCs express CD105, CD73, and CD90, wherein <2% of the transfected MSCs express CD45, CD34, CD14, and HLA-DR surface molecules, and wherein the transfected MSCs are capable of differentiating into osteoblasts, adipocytes, and chondroblasts *in vitro*.

3. The method of claim 1 or 2, wherein the step of exposing the MSCs to the first and second agents comprises replacing the transfection mixture with cell culture media supplemented with the first agent and second agent.

4. The method of any one of claims 1-3, wherein the step of exposing the MSCs to the transfection mixture comprises adding the transfection mixture to the MSCs without removing a growth medium from the MSCs, and centrifugation is not performed during the steps of exposing and incubating.

5. The method of any one of claims 1, 2 and 4, wherein the step of exposing the MSCs to the first agent and the second agent comprises adding the first and second agent to the MSCs simultaneously, sequentially, or in combination with the transfection mixture.

6. The method of any one of claims 1, 2, 4 and 5, wherein a duration of exposure of the MSCs to the transfection mixture overlaps with a duration of exposure of the MSCs to the first and second agents, preferably wherein the transfection mixture is not removed before the first and second agents are added to the MSCs.

7. A method for transfecting mesenchymal stem cells (MSCs) with a nucleic acid construct from which one or more functional genes are expressed, the method comprising:

culturing the MSCs in a growth medium;

adding a transfection mixture comprising the nucleic acid construct which is complexed with a cationic polymer to the MSCs without removing the growth medium from the MSCs;

adding a first agent capable of redirecting endocytosed nucleic acids from intracellular acidic compartments and a second agent capable of stabilizing a microtubular network of the MSCs to the MSCs; and

incubating the MSCs while in contact with all of the transfection mixture, the first agent, and the second agent for an incubation period;

wherein the first and second agents are added to the MSCs simultaneously with the addition of the transfection mixture, sequentially with the addition of the transfection mixture, or in combination with the transfection mixture; and

wherein the MSCs are not centrifuged between the adding of the transfection mixture and expiry of the incubation period;

wherein the first agent comprises a fusogenic lipid, wherein the fusogenic lipid is selected from a group consisting of DOPE, CHEMS, DPPC, DOPC, and combinations thereof;

wherein the second agent is a histone deacetylase inhibitor (HDACi);

wherein the cationic polymer is linear polyethylenimine (LPEI);

thereby providing MSCs transfected with the nucleic acid construct.

9. The method of any one of claims 1-8, wherein the MSCs are transfected with the nucleic acid construct from which one or more functional genes are expressed, the MSCs having a multipotent phenotype which is substantially unchanged by the transfection of the nucleic acid construct, and the MSCs being free of virus-based transfection vehicle materials.

10. The method of any one of claims 1-9, wherein the transfected MSCs transiently express the one or more functional genes for at least 7, at least 8, at least 9, at least 10, at least 11, at least 12, at least 13, at least 14, at least 15, at least 16, or at least 17 days following transfection.

11. The method of any one of claims 1-10, wherein the transfected MSCs are for use in treating cancer, wherein the cancer is lymphoma, clear cell carcinoma, glioblastoma, temozolomide resistant glioblastoma, perianal carcinoma, oral melanoma, thyroid carcinoma, soft tissue carcinoma, cancer ulceration, nasal tumor, or gastrointestinal cancer.

12. The method of any one of claims 1-11, wherein the MSCs are for use in combination with 5-fluorocytosine (5FC), 5-fluorouracil (5FU), ganciclovir (GCV), or any combination thereof.