Cell Therapy - Technologies, Markets and Companies

Description: This report describes and evaluates cell therapy technologies and methods, which have already started to play an important role in the practice of medicine. Hematopoietic stem cell transplantation is replacing the old fashioned bone marrow transplants. Role of cells in drug discovery is also described. Cell therapy is bound to become a part of medical practice.

Stem cells are discussed in detail in one chapter. Some light is thrown on the current controversy of embryonic sources of stem cells and comparison with adult sources. Other sources of stem cells such as the placenta, cord blood and fat removed by liposuction are also discussed. Stem cells can also be genetically modified prior to transplantation.

Cell therapy technologies overlap with those of gene therapy, cancer vaccines, drug delivery, tissue engineering and regenerative medicine. Pharmaceutical applications of stem cells including those in drug discovery are also described. Various types of cells used, methods of preparation and culture, encapsulation and genetic engineering of cells are discussed. Sources of cells, both human and animal (xenotransplantation) are discussed. Methods of delivery of cell therapy range from injections to surgical implantation using special devices.

Cell therapy has applications in a large number of disorders. The most important are diseases of the nervous system and cancer which are the topics for separate chapters. Other applications include cardiac disorders (myocardial infarction and heart failure), diabetes mellitus, diseases of bones and joints, genetic disorders, and wounds of the skin and soft tissues.

Regulatory and ethical issues involving cell therapy are important and are discussed. Current political debate on the use of stem cells from embryonic sources (hESCs) is also presented. Safety is an essential consideration of any new therapy and regulations for cell therapy are those for biological preparations.

The cell-based markets was analyzed for 2016, and projected to 2026. The markets are analyzed according to therapeutic categories, technologies and geographical areas. The largest expansion will be in diseases of the central nervous system, cancer and cardiovascular disorders. Skin and soft tissue repair as well as diabetes mellitus will be other major markets.

The number of companies involved in cell therapy has increased remarkably during the past few years. More than 500 companies have been identified to be involved in cell therapy and 305 of these are profiled in part II of the report along with tabulation of 291 alliances. Of these companies, 170 are involved in stem cells. Profiles of 72 academic institutions in the US involved in cell therapy are also included in part II along with their commercial collaborations. The text is supplemented with 64 Tables and 22 Figures. The bibliography contains 1,200 selected references, which are cited in the text.

The report includes information on the following areas:

- Introduction to Cell Therapy
- Cell Therapy Technologies
- Stem Cells
- Clinical Applications of Cell Therapy
- Cell Therapy of Cardiovascular Disorders
- Cell Therapy for Cancer
- Cell Therapy for Neurological Disorders
- Ethical, regulatory, and, safety Aspects of Cell Therapy
- Markets and future prospects for Cell Therapy
- Companies Involved in Cell Therapy
- Academic Institutions Involved in Cell Therapy

Contents: Part I: Technologies, Ethics & Regulations
0. Executive Summary

1. Introduction to Cell Therapy
   Introduction
   Historical landmarks of cell therapy
   Interrelationship of cell therapy technologies
   Cells and organ transplantation
   Cells and protein/gene therapy
   Cell therapy and regenerative medicine
   Cell therapy and tissue engineering
   Therapy based on cells involved in disease
   Advantages of therapeutic use of cells
   Synthetic cell therapy
   Cell-based drug delivery
   Cells as vehicles for gene delivery
   Red blood cells as vehicles for drug delivery
   Advantages of cell-based drug delivery
   Limitations of cell-based drug delivery

2. Cell Therapy Technologies
   Introduction
   Cell types used for therapy
   Sources of cells
   Bone marrow
   Blood component therapy
   Therapeutic apheresis
   Leukoreduction
   Platelet therapy
   Cell lines
   Immortalized cells
   Xenografts
   Basic technologies for cell therapy
   Cell culture
   Automated cell culture devices
   Cell culture for adoptive cell therapy
   Observation of stem cell growth and viability
   OpTmizer™ CTS™ T cell expansion tissue culture medium
   Companies involved in cell culture
   Cell sorting
   Flow cytometry
   Applications of flow cytometry
   A dielectrophoretic system for cell separation
   Adult stem cell sorting by identification of surface markers
   ALDESORTER system for isolation of stem cells
   Dynabead technology for cell sorting
   Elutra® Cell Separation System
   Magnetophoretic array-based cell sorting for further studies
   Molecular beacons for specific detection and isolation of stem cells
   Multitarget magnetic activated cell sorter
   Nanocytometry
   Scepter™ cytometer
   Companies supplying cell sorters
   Cell analysis
   Cell analyzers
   In vivo cell imaging
   Measuring cell density
   Single-cell gene expression analysis
   Fluorescent in situ RNA sequencing
   Single-cell RNA sequencing of stem cells
   Preservation of cells
   Innovations in cryopreservation
   Packaging of cells
   Selective expansion of T cells for immunotherapy
Cloning and cell therapy
Techniques for cell manipulation
Altering function of adult human cells
Cell-based drug discovery
Advantages and limitations of cell-based assays for drug discovery
Advantages and limitations of cell-based toxicity screening
Quality control of cells for drug discovery
Companies involved in cell-based drug discovery
Introduction of foreign materials into cells to develop therapeutics
Use of cell-penetrating peptides for intracellular transduction
Drug delivery systems for cell therapy
Intravenous delivery of stem cells
Intraarterial delivery of stem cells
Pharmacologically active microcarriers
Targeted delivery of engineered cells to specific tissues via circulation
Devices for delivery of cell therapy
Artificial cells
Applications of artificial cells
Cell encapsulation
Cell-in-a-Box®
Diffusion capsule for cells
Encapsulated cell biodelivery
Therapeutic applications of encapsulated cells
Nitric oxide delivery by encapsulated cells
Implantation of microencapsulated genetically modified cells
Ferrofluid microcapsules for tracking with MRI
Companies involved in encapsulated cell technology
Electroporation
Gene therapy
Cell-mediated gene therapy
Fibroblasts
Chondrocyte
Skeletal muscle cells
Vascular smooth muscle cells
Keratinocytes
Hepatocytes
Lymphocytes
Cell-based CRISPR delivery
In vivo tracking of cells
Molecular imaging for tracking cells
MRI technologies for tracking cells
Superparamagnetic iron oxide nanoparticles as MRI contrast agents
Survival of labeled hMSCs in regenerative therapy grafts
Visualization of gene expression in vivo by MRI
Optogenetic monitoring of cell therapies
Role of nanobiotechnology in development of cell therapy
Nano-biocomposites containing living cells
Cell transplantation for development of organs
Cells transplantation and tolerance
Strategies to improve tolerance of transplanted cells
Encapsulation to prevent immune rejection
Expansion of allospecific regulatory T cells
Prevention of rejection of xenotransplants
Removal and replacement of pathogenic cells of the body
Therapeutic leukocytapheresis

3. Stem Cells
Introduction
Biology of stem cells
Embryonic stem cells
Growth and differentiation of ESCs
Mechanisms of differentiation of ESCs
Chemical regulation of stem cell differentiation
In vitro differentiation of hESCs
SIRT1 regulation during stem cell differentiation
Regulation of stem cell self-renewal and differentiation
hESCs for reprogramming human somatic nuclei
Stem cells differentiation in the pituitary gland
Influence of microenvironment on ESCs
Role of genes in differentiation of ESCs
Global transcription in pluripotent ESCs
Role of p53 tumor suppressor gene in stem cell differentiation
Role of Pax3 gene in stem cell differentiation
Signaling pathways and ESC genes
Epigenetics of hESCs
Chromatin as gene regulator for ESC development
Mechanism of regulation of stem cells for regeneration of body tissues
Role of microenvironments in the regulation of stem cells
Regulation and regeneration of intestinal stem cells
Parthenogenesis and human stem cells
Uniparental ESCs
Haploid ESCs
Bone marrow stem cells
Hematopoietic stem cells
Clonal events that regulate HSC development
Derivation of HSCs from ESCs
Role of HSCs in the immune system
Mesenchymal stem cells
Cryopreservation of MSCs
Multipotent adult progenitor cells
Side population stem cells
Differentiation of adult stem cells
Growth and differentiation of HSCs
HSCs and aging
Mathematical modeling of differentiation of HSCs
Role of prions in self renewal of HSCs
Signaling pathways in the growth and differentiation of HSCs
Sources of stem cells
Sources of of human embryonic stem cells
Nuclear transfer to obtain hESCs
Direct derivation of hESCs from embryos without nuclear transfer
Alternative methods of obtaining hESCs
Establishing hESC lines without destruction of embryo
Altered nuclear transfer
Advantages and disadvantages of ESCs for transplantation
Use of ESC cultures as an alternative source of tissue for transplantation
Spermatogonial stem cells
Very small embryonic-like stem cells
Amniotic fluid as a source of stem cells
Amniotic fluid stem cells for tissue repair and regeneration
Generation of iPS cells from AF cells
Placenta as source of stem cells
Amnion-derived multipotent progenitor cells
Placenta as a source of HSCs
Umbilical cord as a source of MSCs
Umbilical cord blood as source of neonatal stem cells
Cryopreservation of UCB stem cells
Epigenetic programming for expansion of UCB cells
UCB as source of MSCs
Applications of UCB
Advantages of UCB
Limitations of the use of UCB and measures to address them
Licensing and patent disputes involving UCB
Infections following UCB transplants
Unanswered questions about UCB transplantation
Companies involved in UCB banking
ESC banking
Stem cell technologies
Analysis of stem cell growth and differentiation
Activation of bone marrow stem cells into therapeutic cells
Role of nitric oxide in stem cell mobilization and differentiation
Role of natriuretic peptide receptor-C in self-renewal of murine ESCs
Stem cell biomarkers
Endoglin as a functional biomarker of HSCs
STEMPRO® EZChek® for analysis of biomarkers of hESCs
SSEA-4 as biomarker of MSCs
p75NTR as a biomarker to isolate adipose tissue-derived stem cells
Neural stem cell biomarker
Protein expression profile as biomarker of stem cells
Real-time PCR for quantification of protein biomarkers
Study of stem cell pathways
Stem cell genomics
Gene expression in hESCs
Genomic alterations in cultured hESCs
Study of transcriptional regulation of stem cell genes
Casanova gene in zebrafish
Nanog gene
Gene inactivation to study hESCs
RNAi to study gene inactivation in hESCs
Study of ESC development by inducible RNAi
Targeting Induced Local Lesions in Genomes
Homologous recombination of ESCs
Gene modification in genomes of hESCs and hiPSCs using zinc-finger nuclease
miRNA and stem cells
Role of miRNAs in gene regulation during stem cell differentiation
Influence of miRNA on stem cell formation and maintenance
Transcriptional regulators of ESCs control miRNA gene expression
Stem cells and cloning
Cell nuclear replacement and cloning
Nuclear transfer and ESCs
Cloning from differentiated cells
Cloning mice from adult stem cells
Creating interspecies stem cells
Cloned cells for transplantation medicine
Claims of cloning of hESCs
hESCs derived by SCNT
Cytogenetics of embryonic stem cells
Stem cell proteomics
Comparative proteomic analysis of somatic cells, iPSCs and ESCs
hESC phosphoproteome
Proteomic studies of mesenchymal stem cells
Proteomic profiling of neural stem cells
Proteome Biology of Stem Cells Initiative
Technologies for mobilization, expansion, and engraftment of stem cells
Chemoattraction of neuronal stem cells through GABA receptor
Enhancement of HSC engraftment by calcium-sensing receptor
Ex vivo expansion of human HSCs in culture
Ex vivo expansion of MSCs
Ex vivo expansion of UCB cells for transplantation
Expansion of adult stem cells by activation of Oct4
Expansion of transduced HSCs in vivo
Expansion of stem cells in vivo by Notch receptor ligands
In vivo adipogenesis induced by adipose tissue-derived stem cells
Selective mobilization of progenitor cells from bone marrow
Selective Amplification
Synthetic substrates for ESC growth and expansion
Technologies for inducing differentiation of stem cells
Enhancement of stem cell differentiation by Homspera
Generation of RBCs from hESCs
Generation of multiple types of WBCs from hESCs and iPSCs
Growth factor-induced differentiation of MAPCs
Lineage selection to induce differentiation of hESCs
Mechanical strain to induce MSC differentiation
Neurotrophin-mediated survival and differentiation of hESCs
Synthetic biology and stem cells
Use of RNAi to expand the plasticity of autologous adult stem cells
Use of carbohydrate molecules to induce differentiation of stem cells
Limitations of the currently available stem cell lines in the US
Stem cell separation
Stem cell culture
Culture of hMSCs
Elimination of contaminating material in stem cell culture
Long-term maintenance of MSC multipotency in culture
Nanofiber scaffolds for stem cell culture
Conversion of stem cells to functioning adipocytes
Mass production of ESCs
Promoting survival of dissociated hESCs
Analysis and characterization of stem cells
Harvesting and identification of EPCs
Labeling of stem cells
Labeling, imaging and tracking of stem cells in vivo
Perfluorocarbon nanoparticles to track therapeutic cells in vivo
PET imaging for tracking of stem cells
Project for imaging in stem cell therapy research
Quantum dots for labeling and imaging of stem cells
Radiolabeling of MSCs for in vivo tracking
Superparamagnetic iron oxide nanoparticles for tracking MSCs
Tracking of transplanted muscle stem cells
Applications of stem cells
Commercial development and applications of adult stem cells
Preparation of cells for therapeutic administration to patients
Retrodifferentiation of stem cells
MultiStem
Controlling the maintenance process of hematopoietic stem cells
Self renewal and proliferation of HSCs
Aging and rejuvenation of HSCs
Aging and MSCs
iPSC-based modeling of late-onset age-related diseases
Peripheral blood stem cell transplantation
Role of stem cells in regeneration
Pluripotent stem-cell-derived gastric organoids
Promotion of regeneration by Wnt/beta-catenin signaling
Stem cell activation for regeneration by using glucocorticoids
Stem cells and human reproduction
Expansion of spermatogonial stem cells
Conversion of ESCs into spermatogonial stem cells
Conversion of stem cells to oocytes
ESCs for treatment of infertility in women
Cloning human embryos from oocytes matured in the laboratory
In utero stem cell transplantation
Innovations in delivery of stem cells
Polymeric capsules for stem cell delivery
Immunological aspects of hESC transplantation
Immunosuppression to prevent rejection of hESC transplants
Histocompatibility of hESCs
Strategies for promoting immune tolerance of hESCs
Stem cells for organ vascularization
Activation of EphB4 to enhance angiogenesis by EPCs
Advantages and limitations of clinical applications of iPSCs
Advantages and limitations of clinical applications of MSCs
Biofusion by genetically engineering stem cells
Stem cell gene therapy
Combination of gene therapy with nuclear transfer
Gene delivery to stem cells by artificial chromosome expression
Genetic manipulation of ESCs
Genetic engineering of human stem cells for enhancing angiogenesis
HSCs for gene therapy
iPSCs for targeted gene correction of α1-antitrypsin deficiency
Helper-dependent adenoviral vectors for gene transfer in ESCs
Lentiviral vectors for in vivo gene transfer to stem cells
Linker based sperm-mediated gene transfer technology
Mesenchymal stem cells for gene therapy
Microporation for transfection of MSCs
Regulation of gene expression for SC-based gene therapy
Stem cells and in utero gene therapy
Therapeutic applications for hematopoietic stem cell gene transfer
Targeted genome editing for human repopulating HSCs
The future of hematopoietic stem cell gene therapy
Stem cell pharmaceutics
Pharmaceutical manipulation of stem cells
Expansion of HSCs in culture by inhibiting aldehyde dehydrogenase
Expansion of HSCs in vivo by use of prostaglandin E2
Manipulation of stem cells with growth factors
Mobilization of stem cells by cytokines/chemokines
Mobilization of adult human HSCs by use of inhibitors
Mobilization of stem cells by HYC750
Mobilization of stem cells by hyperbaric oxygen
Mobilization by adenoviral vectors expressing angiogenic factors
Stem cell mobilization by acetylcholine receptor agonists
Use of parathyroid hormone to increase HSC mobilization
Use of small molecule compounds for expansion of HSCs
Use of a small molecule for targeting systemically infused MSCs
Role of stem cells in therapeutic effects of drugs
Stem cells for drug discovery
Target identification
High-throughput screening
ESCs as source of models for drug discovery
hESC-derived hepatocytes for drug discovery
hESC-derived cardiomyocytes for drug discovery
iPSCs for drug discovery
Advantages and limitations of use of stem cells for drug discovery
Stem cells for drug delivery
Toxicology and drug safety studies using ESCs versus other cells
Future challenges for stem cell technologies
Generation of patient-specific pluripotent stem cells
Hybrid embryos/cybrids for stem cell research
In vivo study of human hematopoietic stem cells
Inhibition of stem cell-derived teratoma formation by small molecules
Markers for characterizing hESC lines
MBD3-deficient ESC line
Research into plasticity of stem cells from adults
Reversion of human stem cells to ground state pluripotency
Stem cell biology and cancer
Stem cells and aging
Stem cells in space
Study of the molecular mechanism of cell differentiation
Switch of stem-cell function from activators to repressors
Stem cell research at academic centers
International Regulome Consortium
Companies involved in stem cell technologies
Concluding remarks about stem cells
Challenges and future prospects of stem cell research

4. Clinical Applications of Cell Therapy

Introduction
Cell therapy for hematological disorders
Transplantation of autologous hematopoietic stem cells
HSCs derived from pluripotent stem cells
Hemophilias
Ex vivo cell/gene therapy of hemophilia B
Cell/gene therapy of hemophilia A
Hematopoietic stem cell therapy for thrombocytopenia
Stem cell transplant for sickle cell anemia
Treatment of chronic acquired anemias
Implantation of genetically engineered HSCs to deliver rhEpo
Drugs acting on stem cells for treatment of anemia
Stem cell therapy of hemoglobinopathies
iPSC-based therapy for β-thalassemia
Stem cells for treatment of immunoglobulin-light chain amyloidosis
Future prospects of cell therapy of hematological disorders
Cell therapy for immunological disorders
Role of dendritic cells in the immune system
Modifying immune responses of DCs by vaccination with lipiodol-siRNA mixtures
Potential of MSCs as therapy for immune-mediated diseases
Stem cell therapy of chronic granulomatous disease
Stem cell therapy of X-linked severe combined immunodeficiency
Stem cell therapy of autoimmune disorders
Wiskott-Aldrich Syndrome
Treatment of rheumatoid arthritis with stem cells
Treatment of Crohn's disease with stem cells
Stem cell transplants for scleroderma
Role of T Cells in immunological disorders
Autologous T cells from adult stem cells
Cell therapy for graft vs host disease
T cell infusion for suppressing GVHD
Genetically modified Tregs expressing CAR for prevention of GVHD
MSCs for GVHD
Cell therapy for viral infections
Anti-HIV ribozyme delivered in hematopoietic progenitor cells
Dendritic-cell targeted DNA vaccine for HIV
Exosomes and viral infections
Manipulation of T cells for treatment of viral infections
T cell therapy for CMV
T cell therapy for HIV infection
T cell immunity by Overlapping Peptide-pulsed Autologous Cells
Modification of iPSCs with a mutation to confer resistance to HIV
Cell therapy of lysosomal storage diseases
Niemann-Pick disease
Gaucher's disease
Fabry's disease
Cell therapy for endocrine disorders
Hypopituitarism
Adrenal insufficiency
Cell therapy for diabetes mellitus
Limitations of current treatment
Limitations of insulin therapy for diabetes mellitus
Limitations of pancreatic transplantation
Islet cell transplantation
Autologous pancreatic islet cell transplantation in chronic pancreatitis
Clinical trials of pancreatic islet cell transplants for diabetes
Drawbacks of islet cell therapy
Use of an antioxidant peptide to improve islet cell transplantation
Cdk-6 and cyclin D1 enhance human beta cell replication and function
Devices for delivery of therapeutic cells in diabetes
Monitoring of islet cell transplants with MRI
Concluding remarks about allogeneic islet transplantation for diabetes
Encapsulation of insulin producing cells
Encapsulated porcine pancreatic islet cells for pancreas
Encapsulated insulinoma cells
Magnetocapsule enables imaging/tracking of islet cell transplants
Islet precursor cells
Dedifferentiation of β cells to promote regeneration
Pharmacological approaches for β cell regeneration
Xenotransplantation of embryonic pancreatic tissue
Non-pancreatic tissues for generation of insulin-producing cells
Exploiting maternal microchimerism to treat diabetes in the child
Bio-artificial substitutes for pancreas
Role of stem cells in the treatment of diabetes
Embryonic stem cells for diabetes
HSC transplantation to supplement immunosuppressant therapy
Insulin-producing cells derived from UCB stem cells
iPSc for diabetes
Pancreatic stem cells
Stem cell injection into portal vein of diabetic patients
Conversion of progenitor cells into insulin-producing cells
Human neural progenitor cells converted into insulin-producing cells
Isolation of islet progenitor cells
Pancreatic progenitor cells
Cell-based immunotherapy for type 1 diabetes
Dendritic cell-based therapy
T regulatory cell therapy for diabetes
Vaccine for diabetes
Gene therapy in diabetes
Viral vectors for gene therapy of diabetes
Genetically engineered dendritic cells
Genetically altered liver cells
Genetically modified stem cells
Companies developing cell therapy for diabetes
Concluding remarks about cell and gene therapy of diabetes
Cell therapy of gastrointestinal disorders
Inflammatory bowel disease
Cell therapy for liver disorders
Types of cells used for hepatic disorders
Culture and expansion of primary human hepatocytes
Hepatocyte progenitor cells
Hybrid periportal hepatocytes
Methods of delivery of cells for hepatic disorders
Hepatic failure
Bioartificial liver
Hepatocyte-based artificial liver
Extracorporeal Liver Assist Device
Limitations of bioartificial liver
Proliferating cell-based bioartificial liver
Stem cells for hepatic disorders
Deriving hepatocytes from commercially available hMSCs
Implantation of hepatic cells derived from hMSCs of adipose tissue
Heterologous adult liver progenitor cells
Liver stem cell culture
MSC derived molecules for reversing hepatic failure
Cell-based gene therapy for liver disorders
Transplantation of genetically modified fibroblasts
Transplantation of genetically modified hepatocytes
Genetically modified hematopoietic stem cells
iPSCs derived from somatic cells for liver regeneration
Hepatocyte-like cells derived from human parthenogenetic stem cells
Clinical applications
Future prospects of cell-based therapy of hepatic disorders
Cell therapy of renal disorders
Bioartificial kidney
Cell-based repair for vascular access failure in renal disease
Mesangial cell therapy for glomerular disease
Stem cells for renal disease
Role of stem cells in renal repair
Bone marrow stem cells for renal disease
Human amniotic fluid stem cells for renal regeneration
MSC therapy for renal disease
MSCs as aid to renal graft survival
Transplantation of cell-based bioengineered kidney
Cell therapy for pulmonary disorders
Delivery of cell therapy for pulmonary disorders
Intratracheal injection of cells for pulmonary hypoplasia
Role of stem cells in pulmonary disorders
Lung stem cells
Lung tissue regeneration from stem cells
Role of autologous MSCs in the treatment of severe emphysema
Role of stem cells in construction of the Cyberlung
Respiratory epithelial cells derived from UCB stem cells
Respiratory epithelial cells derived from hESCs
Lung tissue engineering with adipose stromal cells
Cell-based tissue-engineering of airway
Pulmonary disorders that can be treatable with stem cells
Acute lung injury and ARDS treated with MSCs
Bronchopulmonary dysplasia treated with MSCs
Chronic obstructive pulmonary disease treated with MSCs
Cystic fibrosis treatment with genetically engineered MSCs
Idiopathic pulmonary fibrosis
Lung regeneration by integrin a6b4-expressing alveolar epithelial cell
Pulmonary arterial hypertension treatment with EPCs
Cell therapy for disorders of bones, joints and tendons
Cell therapy for repair of fractures and bone defects
Bone regeneration by human very small embryonic-like (hVSEL) cells
Cell therapy for cervical vertebral interbody fusion
Cell-mediated gene therapy for bone regeneration
ESCs for bone repair
hiPSCs for engineering personalized bone grafts
Intrauterine use of MSCs for osteogenesis imperfecta
In vivo bone engineering as an alternative to cell transplantation
In vivo differentiation of pluripotent stem cells for bone regeneration
MSCs for repair of bone defects
MSCs for repair of bone fractures
Osteocalcophel
Stem cells for repairing skull defects
Stem cell-based bone tissue engineering
Spinal fusion using stem cell-based bone grafts
Wnt stimulation to enrich BMMCs for repair of bone fractures
Cell therapy of tendon injuries
Autologous tenocyte implantation in rotator cuff injury repair
Platelet injection for tennis elbow
Cell-based techniques for cartilage repair and regeneration
Cartilage generation from stem cells
Cartilage engineering from iPSCs
Genetically modified fibroblasts expressing TGF-ß for cartilage repair
Juvenile cartilage implant for repair of damage to articular cartilage
Cell therapy for repair of knee cartilage injuries
Autologous chondrocyte therapy of the knee
Meniscus-derived stem cells
MSC-based constructs for knee joint replacement
Nanobiotechnology scaffolds for MSC-based cartilage reconstruction
Role of cells in the repair of anterior cruciate ligament injury
Osteoporosis
Stem cell gene therapy for osteoporosis
Osteoarthritis of the joints
Autologous cultured chondrocytes
Autologous intervertebral disc chondrocyte transplantation
Intraarticular MSCs for osteoarthritis
Mosaicplasty
Stem cell therapy of osteoarthritis of the knee
Osteonecrosis
Cell therapy for osteonecrosis
Cell therapy for radionecrosis
Repair of osteonecrosis by bone marrow derived MSCs
Rheumatoid arthritis
Cell therapy for diseases of the eye
Cell therapy for corneal repair
Lens regeneration from endogenous stem cells
Stem cell therapy for limbal stem cell deficiency
Role of stem cells in fibrosis following eye injury
Stem cell transplantation for radiation sickness
MSCs for treatment of radiation damage to the bone
MSCs for regeneration of ovaries following radiotherapy damage
Cell therapy for wound healing
Cells to form skin substitutes for healing ulcers
CellSpray for wound repair
Cell therapy for burns
Closure of incisions with laser guns and cells
Genetically engineered keratinocytes for wound repair
MSCs for wound healing
Role of amniotic fluid MSCs in repair of fetal wounds
Role of cells in regenerative medicine
Stem cells for regeneration of skin and appendages
Bifunctional ectodermal stem cells and nail regeneration
Stem cells for regeneration of skin in junctional epidermolysis bullosa
Follicular stem cells for skin and wound repair
Regeneration of aging skin by adipose-derived stem cells
Reprogramming autologous stem cells for regeneration of skin
Concluding remarks on regeneration of skin by stem cells
Cell therapy for regeneration of muscle wasting
Role of stem cells in regeneration of esophageal epithelium
Stem cell-based regenerative therapy for xerostomia
Concluding remarks for use of cells in regenerative medicine
Genomic studies for examining the role of stem cells in regeneration
Cell therapy for regenerating organs
Umbilical cord blood for regeneration
Future prospects of stem cells for regenerative medicine
Role of cells in tissue engineering and reconstructive surgery
Scaffolds for tissue engineering
Improving vascularization of engineered tissues
Reconstruction of vasculature
Repair of aging skin by injecting autologous fibroblasts
Enhancing vascularization by combining cell and gene therapy
Nanobiotechnology applied to cells for tissue engineering
Choosing cells for tissue engineering
Stem cells for tissue repair
ESCs vs adult SCs for tissue engineering
Use of adult MSCs for tissue engineering
Measuring MSC interactions with environment for tissue engineering
Stem cells for tissue engineering of various organs
Breast reconstruction by adipose tissue-derived stem cells
Engineering of healthy living teeth from stem cells
Intra-uterine repair of congenital defects using amniotic fluid MSCs
Skin regeneration by stem cells as an alternative to face transplant
Tissue engineering of bone by stem cells
Cell-based tissue engineering in genitourinary system
Urinary incontinence
Tissue engineering of urinary bladder
Label retaining urothelial cells for bladder repair
MSCs for bladder repair

RESEARCH AND MARKETS
Tissue-engineering of urethra using autologous cells
Reconstruction of vagina from stem cells
Reconstruction of cartilage for repair of craniofacial defects
Intraoperative cell therapy
Cell therapy for rejuvenation
Reversal of muscle weakness and atrophy in aging
Reversal of cognitive impairment in aging
Cell therapy for performance enhancement in sports
Application of stem cells in veterinary medicine
Use of stem cells to repair tendon injuries
Stem cells for spinal cord injury in dogs

5. Cell Therapy for Cardiovascular Disorders
Introduction to cardiovascular disorders
Limitations of current therapies for myocardial ischemic disease
Types of cell therapy for cardiovascular disorders
Cell-mediated immune modulation for chronic heart disease
Inducing the proliferation of cardiomyocytes
Pericardial origin of colony-forming units
Role of splenic myocytes in repair of the injured heart
Reprogramming of fibroblasts into functional cardiomyocytes
Stem cell-based therapies for cardiovascular diseases
Human cardiovascular progenitor cells
Human pluripotent stem cell-derived cardiomyocytes
Magnetic antibody-linked nanoparticles to deliver cells to the heart
Role of the SDF-1-CXCR4 axis in therapies for myocardial ischemia
Small molecules to enhance myocardial repair by stem cells
Stem cells and atherosclerosis
Cell therapy for atherosclerotic coronary artery disease
MyoCell™ (Bioheart)
Cardiac stem cells
Cardiomyocytes derived from epicardium
Cardiac atrial appendage stem cells
Methods of delivery of cells to the heart
Cellular cardiomyoplasty
IGF-1 delivery by nanofibers to improve cell therapy for MI
Non-invasive delivery of cells to the heart by Morph®guide catheter
Cell therapy for cardiac revascularization
Transplantation of cardiac progenitor cells for revascularization of myocardium
Stem cells to prevent restenosis after coronary angioplasty
Role of cells in cardiac tissue repair
Modulation of cardiac macrophages for repair of infarct
Transplantation of myoblasts for myocardial infarction
Patching myocardial infarction with fibroblast culture
Cardiac repair with myoendothelial cells from skeletal muscle
Myocardial tissue engineering
Role of stem cells in repair of the heart
Role of stem cells in cardiac regeneration following injury
Cardiomyocytes derived from adult skin cells
Cardiomyocytes derived from ESCs
Cardiomyocyte differentiation from hiPSCs
Studies to identify subsets of progenitor cells suitable for cardiac repair
Technologies for preparation of stem cells for cardiovascular therapy
Pravastatin for expansion of endogenous progenitor and stem cells
Cytokine preconditioning of human fetal liver CD133+ SCs
Expansion of adult cardiac stem cells for transplantation
Role of MSCs in growth of CSCs
Role of ESCs in repair of the heart
ESC transplantation for tumor-free repair of the heart
Transplantation of stem cells for myocardial infarction
Autologous bone marrow-derived stem cell therapeutics
Autologous bone marrow-derived mesenchymal precursor stem cells
Intracoronary infusion of mobilized peripheral blood stem cells
Transplantation of cord blood stem cells
Transplantation of hESCs
Transplantation of HSCs
Transplantation of autologous angiogenic cell precursors
Transplantation of adipose-derived stem cells
Transplantation of bone marrow-derived cells for myocardial infarct
Transplantation of human umbilical cord perivascular cells
Transplantation of endothelial cells
Transplantation of cardiomyocytes differentiated from hESCs
Stem cell therapy for cardiac regeneration
Cryopreserved hESC-derived cardiomyocytes for cardiac regeneration
HSCs for regeneration of the chronic myocardial infarcts
Human MSCs for cardiac regeneration
In vivo tracking of MSCs transplanted in the heart
MSCs for hibernating myocardium
Simultaneous transplantation of MSCs and skeletal myoblasts
Transplantation of genetically modified cells
Transplantation of genetically modified MSCs
Transplantation of cells secreting vascular endothelial growth factor
Transplantation of genetically modified bone marrow stem cells
Cell transplantation for congestive heart failure
AngioCell gene therapy for congestive heart failure
Injection of adult stem cells for CHF
Intracoronary infusion of cardiac stem cells
Myoblasts for treatment of congestive heart failure
Stem cell therapy for dilated cardiac myopathy
Role of cell therapy in cardiac arrhythmias
Biological pacemakers
Stem cells as biological pacemakers
Stem cells for cardiac arrhythmias
Prevention of myoblast-induced arrhythmias by genetic engineering
Ventricular tachycardia
ESCs for correction of congenital heart defects
Cardiac progenitors cells for treatment of heart disease
Autologus stem cells for chronic myocardial ischemia
Role of cells in cardiovascular tissue engineering
Cell-based in vitro regeneration of heart for transplantation
Construction of blood vessels with cells
Engineered arteries for bypass grafts
Engineering heart valves with UCB progenitor cells
Epicardial regeneration from hPSCs
Fetal cardiomyocytes seeding in tissue-engineered cardiac grafts
Targeted delivery of endothelial progenitor cells labeled with nanoparticles
Cell therapy for peripheral vascular disease
ALD-301
Cell/gene therapy for PVD
Cell therapy for CLI in diabetics
Colony stimulating factors for enhancing peripheral blood stem cells
Intramuscular autologous bone marrow cells
Ixmyelocel-T cell therapy for critical limb ischemia
Stem cell-coated vascular grafts for femoral-tibial arterial bypass
Clinical trials of cell therapy in cardiovascular disease
Mechanism of the benefit of cell therapy for heart disease
A critical evaluation of cell therapy for heart disease
Publications of clinical trials of cell therapy for CVD
Current status of cell therapy for cardiovascular disease
Future directions for cell therapy of CVD
Combination of cells with biomedical scaffolds
Prospects of adult stem cell therapy for repair of heart
Role of cells in regeneration of the heart
Regeneration of cardiomyocytes without use of cardiac stem cells
6. Cell Therapy for Cancer

Introduction

Cell therapy technologies for cancer
Cell-based delivery of anticancer therapy
Cellular immunotherapy for cancer
Treatments for cancer by ex vivo mobilization of immune cells
Granulocytes as anticancer agents
Neutrophil granulocytes in antibody-based immunotherapy of cancer
Cancer vaccines
Autologous tumor cell vaccines
BIOVAXID
OncoVAX
Tumor cells treated with dinitrophenyl
Vaccines that simultaneously target different cancer antigens
Gene modified cancer cells vaccines
GVAX cancer vaccines
K562/GM-CSF
Active immunotherapy based on antigen specific to the tumor
The use of dendritic cells for cancer vaccination
Autologous dendritic cells loaded ex vivo with telomerase mRNA
Dendritic cell-targeted protein vaccines
Dendritic/tumor cell fusion
Electro-hyperthermia for improving DC immunotherapy
Genetically modified dendritic cells
In vivo manipulation of dendritic cells
Preclinical and clinical studies with DC vaccines
Vaccines based on dendritic cell-derived exosomes
Limitations of DC vaccines for cancer
Future developments to enhance clinical efficacy of DC vaccines
Cell-based cancer immunotherapy
Adoptive cell therapy
CD8+ T cells for use in tumor immunotherapy
Chimeric antigen receptor T cells
ProCAR-NK cancer immunotherapy
Combination of antiangiogenic agents with ACT
Expansion of antigen-specific cytotoxic T lymphocytes
Genetically modified T cells for targeting tumors
Genetic engineering of tumor cells to activate T helper cells
Targeting T regulatory cells
T cells with immunological memory and stem cell-like properties
Tumor infiltrating lymphocytes
Hybrid cell vaccination
Chemoimmunotherapy
Stem cell-based anticancer therapies
Stem cell transplantation in cancer
Peripheral blood stem cell transplantation
Stem cell transplantation for hematological malignancies
Long-term results of HSC transplantation
Prediction of T cell reconstitution after HSC transplantation.
HSC transplantation followed by GM-CSF-secreting cell vaccines
HSC transplantation for renal cell cancer
Umbilical cord blood transplant for hematological malignancies
Complications of stem cell transplants in cancer
Graft-versus-host disease (GVHD).
Delayed immune reconstitution leading to viral infections and relapse
Tumor cell contamination
Neurological complications
Hepatic veno-occlusive disease
Current status and safety of allogeneic HSC transplantation
Complications of PBSC transplantation in children
Role of MSCs in cancer
MSC-mediated delivery of anticancer therapeutics
Nonmyeloablative allogeneic hematopoietic stem cell transplantation
hESC-derived NK cells for treatment of cancer
ESC vaccine for prevention of lung cancer
Genetic modification of stem cells for cancer therapy
Genetic modification of hematopoietic stem cells
Use of hematopoietic stem cells to deliver suicide genes to tumors
Delivery of anticancer agents by genetically engineered MSCs
Mesenchymal progenitor cells for delivery of oncolytic adenoviruses
Genetically modified NSCs for treatment of neuroblastoma
Innovations in cell-based therapy of cancer
Use of immortalized cells
Cancer therapy based on natural killer cells
Cytokine-induced killer cells
Mesothelin as a target for cancer immunotherapy
Nanomagnets for targeted cell-based cancer gene therapy
Implantation of genetically modified encapsulated cells for anticancer therapy
Antiangiogenesis therapy by implantation of microencapsulated cells
Recombinant tumor cells secreting fusion protein
A device for filtering cancer and stem cells in the blood
Cancer stem cells
Cancer stem cell biomarkers
Integrative nuclear signaling and development of cancer in stem cells
Origin of cancer in normal stem cells
Role of intestinal stem cells in intestinal polyposis
Role of endothelial progenitor cells in tumor angiogenesis
Role of cancer stem cells in metastases
Therapeutic implications of cancer stem cells
Targeting breast cancer stem cells
Targeting cancer stem cells in leukemia
Targeting cancer stem cells in ovarian cancer
Targeting cancer stem cells to screen anticancer drugs
Companies involved in cell-based cancer therapy
American Association for Cancer Research and ESCs
Future of cell-based immunotherapy for cancer

7. Cell Therapy for Neurological Disorders
Introduction
Use of stem cells for research in neurosciences
Cerebral organoids for modeling human brain development
Use of human stem cell-derived neurons in neuropharmacology
Regeneration of brain by in vitro/in vivo reprogramming of cells
Molecular mechanism of neurogenesis
Generation of neurons from astroglia
In vivo cell replacement therapy by locally induced neural progenitor cells
In vivo reprogramming to generate new neurons
Types of cells used for treatment of neurological disorders
Activated T lymphocytes
Differentiation of placenta-derived multipotent cells into neurons
Fibroblast-derived human striatal neurons
Mesenchymal stem cells induced to secrete neurotrophic factors
MUSE cells transplantation for neuronal regeneration
Neural stem cells
Development of human CNS stem cells
Direct conversion of adult fibroblasts into neural progenitor cells
Distinction between NSCs and intermediate neural progenitors
Embryonic stem cell-derived neurogenesis
Epidermal neural crest stem cells for neurological disorders
Fusion of NSCs with endogenous neurons
Induction of NSCs from hESCs
Induction of NSCs from adult MSCs
Mechanism of migration of NSCs to sites of CNS injury
Monitoring of implanted NSCs labeled with nanoparticles
Neural progenitor cells
Neural stem cells in the subventricular zone of the brain
Oligodendrocyte progenitor cells
Promotion of neural stem cells expansion by betacellulin
Proteomics of neural stem cells
Regulation of neural stem cells in the brain
Role of CSF proteins in regulation of neural progenitor cells
Sequencing the transcriptomes of neural stem cells
Study of neural differentiation of hESCs by NeuroStem Chip
Transformation of neural stem cells into other cell types
Stem cell transplantation in the CNS
Development of CNS cells from non-CNS stem cells
Expansion of adult human neural progenitors
Hair-follicle stem cells for neural repair
Human NSCs for treatment of neurological disorders
NSCs and scaffolds for regeneration therapy of CNS disorders
Neurospheres
Stem cells from olfactory epithelium for transplantation in the CNS
Stem cells from human umbilical cord blood for CNS disorders
Choroid plexus cells for transplantation
Dental pulp cells for neuroprotection
Derivation of CNS cells from peripheral nervous system
Fetal tissue transplants
Immortalized cells for CNS disorders
Laboratory mice with human brain cells
Olfactory ensheathing cells for CNS repair
Ideal cells for transplantation into the nervous system
Cell therapy techniques for neurological applications
Carbon nanotubes to aid stem cell therapy of neurological disorders
Cell transplantation for regeneration of the nervous system
Cells used for gene therapy of neurological disorders
Fibroblasts
Stem cells
Neuronal cells
Immortalized neural progenitor cells
Astrocytes
Cerebral endothelial cells
Human retinal pigmented epithelial cells
Enhancement of growth of stem cells in the brain by drugs
C3-induced differentiation and migration of NPC for repair of the brain
Stem cell therapies of neurological disorders combined with HBO
hESCs for CNS repair
Motor neurons derived from stem cells
MSCs for CNS repair
Neuronal differentiation of stem cells
Apigenin promotes differentiation of stem cells into neural lineage
Stem cells preparations for CNS disorders
Tracking of stem cells in the CNS by nanoparticles and MRI
Use of neural stem cells to construct the blood brain barrier
Methods of delivery of cells to the CNS
Cerebrospinal fluid-stem cell interactions for therapy of CNS disorders
CNS delivery of cells by catheters
Engineered stem cells for drug delivery to the brain
Encapsulated cells
Intrathecal delivery of stem cells
Intraparenchymal delivery of stem cells to the spinal cord
Intravascular administration
Neural stem cells as therapeutic delivery vehicles
Neurological disorders amenable to cell therapy
Neuroprotection by cell therapy
Cells secreting neuroprotective substances
Stem cells for neuroprotection
Neuroprotection by intravenous administration of HSCs
Human UCB-derived stem cells for the aging brain
Neurodegenerative disorders
MSCs for therapy of neurodegenerative disorders
Role of stem cells in neurodegenerative disorders
Role of NSCs in disorders associated with aging brain
NSCs for improving memory
Parkinson's disease
Cell therapies for PD
Delivery of cells for PD
Dopamine neurons for PD
Encapsulated cells for PD
Graft survival-enhancing drugs
Human retinal pigment epithelium cells for PD
Potential of regeneration of endogenous stem cells in PD
Pluripotent stem cell-derived neurons
Stem cell transplantation in animal models of PD
Stem cells for production of glial derived neurotrophic factor
Transplantation of embryonic medial ganglionic eminence cells
Trials of stem cell transplantation in PD patients
Tumorigenic potential of transplanted dopaminergic hESCs
Xenografting porcine fetal neurons
Personalized stem cell therapy for PD
Future perspectives of clinical trials of stem cell therapy for PD
MSCs for multiple system atrophy
Cell therapy for Huntington's disease
Fetal striatal cell transplantation
Transplantation of encapsulated porcine choroids plexus cells
iPSCs for HD
Mobilization of endogenous neural progenitor cells in HD
Cell therapy for Alzheimer's disease
Choroid plexus epithelial cells for AD
Implantation of genetically engineered cells producing NGF
Implantation of stem cells derived from the skin
Neural stem cell implantation for Alzheimer's disease
Cell therapy for amyotrophic lateral sclerosis
Stem cell techniques for study of ALS
Rational for use of stem cells for ALS
Experimental studies with various types of stem cells for ALS
Clinical trials of stem cells for ALS
Transplantation of glial restricted precursors in ALS
Stem cell-based drug discovery for ALS
Cell therapy for demyelinating disorders
Autologous bone marrow stem cell therapy for multiple sclerosis
ESCs for remyelination
Fusokine method of personalized cell therapy of MS
Genetically engineered macrophages expressing NaV1.5
Hematopoietic stem cell transplantation for MS
Mechanism of repair of demyelination after NSC transplantation
MSCs for multiple sclerosis
Neural progenitor cells for neuroprotection in MS
Oligodendrocyte generation from human iPSCs
T cell-based personalized vaccine for MS
Stem cells for chronic inflammatory demyelinating polyneuropathy
Stem cell transplantation for Pelizaeus-Merzbacher disease
X-linked adrenoleukodystrophy
Cell therapy of stroke
Adult stem cell therapy in stroke
Cell therapy of intracerebral hemorrhage
Implantation of genetically programmed ESCs
Intravenous infusion of MSCs
Intravenous infusion of human UCB stem cells
Intracerebral administration of human adipose tissue stromal cells
Neural stem cell therapy for stroke
Transplantation of encapsulated porcine choroids plexus
Transplantation of fetal porcine cells
Role of cell therapy in management of stroke according to stage
Clinical trials of cell therapy for stroke
Future of cell therapy for stroke
Cell therapy of traumatic brain injury
Cell/gene therapy for TBI
Clinical trials of autologous stem cell therapy for TBI
Limitations of stem cell therapy for acute TBI
Improving the microenvironments of transplanted cells in TBI
Cell therapy for spinal cord injury
Autoimmune T cells against CNS myelin-associated peptide
Fetal neural grafts for SCI
Olfactory-ensheathing cells for SCI
Oligodendrocyte precursor cells for treatment of SCI
Schwann cell transplants for SCI
Transplantation of glial cells for SCI
Stem cells for SCI
Bone marrow stem cells for SCI
Embryonic stem cells for SCI
Transplantation of induced pluripotent stem cells in SCI
Transplantation of MSCs for SCI
Transplantation of NSCs for SCI
Transplantation of human dental pulp stem cells
Transdifferentiation of BM stem cells into cholinergic neurons for SCI
Evaluation of experimental studies of stem cell transplantation in SCI
Spinal stem cells for treatment of ischemic injury of spinal cord
Combined approaches for regeneration in SCI
Combined cell/gene therapy for SCI
Delivery of cells in SCI
Intrathecal injection of cells labeled with magnetic nanoparticles
Intravenous injection of stem cells for spinal cord repair
Clinical applications of stem cells for SCI
Autologous bone marrow cell transplantation for SCI
Cell therapy of syringomyelia
Cell therapy for neurogenetic disorders
Hurler’s syndrome treated with stem cells
Krabbe’s disease treated with UCB stem cells
Krabbe’s disease treated with combination of cell and gene therapy
Mitochondrial encephalomyopathies treated with stem cells
Sanfilippo syndrome type B treated with UCB stem cells
Cell therapy for lysosomal storage disorders
Cell therapy for Batten disease
Cell/gene therapy for Farber’s disease
Genetically modified HSCs for metachromatic leukodystrophy
Neural stem cells for lysosomal storage disorders
Cell therapy of epilepsy
Cell therapy of posttraumatic epilepsy
Cell therapy for temporal lobe epilepsy
Cell therapy for pharmacoresistant epilepsies
Cell therapy for developmental neurological disorders
Cell therapy for cerebral palsy
Cell-based therapies for malignant CNS tumors
Bone morphogenetic protein for inhibition of glioblastoma multiforme
Dendritic cell therapy for brain tumors
Encapsulated cells for brain tumors
Engineered human NSCs for treatment of spinal cord gliomas
Immunotherapy of GBM targeting cancer stem cells
Mesenchymal stem cells for the treatment of gliomas
Neural stem cells for treatment of malignant brain tumors
Role of cancer stem cells in resistance to radiotherapy
Stem cell-based therapy targeting EGFR in GBM
Targeting stem cells in brain tumors
Clinical trials of cell therapy of glioblastoma multiforme
Cell therapy for chemobrain
Cell therapy for muscle disorders
Duchenne muscular dystrophy
Combination of cell and pharmacotherapy for DMD
Myoblast transplant for DMD
Myoblast-based gene transfer
Myoblasts lacking the MyoD gene
Myoblast injection for treatment of other muscular dystrophies
Role of satellite cells in the treatment of DMD
Stem cells for DMD
Wnt7a treatment for DMD
Cell therapy for autism
Management of chronic intractable pain by cell therapy
Implantation of chromaffin cells
Role of stem cells in management of pain
Implantation of astrocytes secreting enkephalin
Cells for delivery of antinociceptive molecules
Implantation of genetically engineered cells
Cell therapy for low back pain
Cell therapy for neuropathic itch
Cell therapy for neuroendocrine disorders
Pituitary stem cells
Cell therapy for retinal degenerative disorders
Delivery of CNTF by encapsulated cell intraocular implants
Genetically engineered retinal pigmented epithelial cell lines
Stem cell-based therapies for retinal degenerative disorders
Adipose-derived stem cells for retinal degeneration
Adipose-derived stem cells transplantation for diabetic retinopathy
ESCs for retinal degenerative disorders
hESC-derived RPE cells for macular dystrophy
Human retinal stem cells
iPSCs for AMD
Neuroprotective effect of neural progenitor cell transplantation
Stem-cell based therapy for retinitis pigmentosa
Stem cell transplantation in the retina
Combining stem cell and gene therapies for retinal disorders
Clinical trials of cell therapy for retinal degenerative disorders
Stem cell therapy for hearing loss
Cell therapy for peripheral nerve lesions
Cell transplants for peripheral nerve injuries
Role of adipose-derived stem cells in peripheral nerve regeneration
Treatment of diabetic neuropathy with endothelial progenitor cells
Complications of cell therapy of neurological disorders
Tumor formation after CNS transplantation of stem cells
Donor stem cell-derived brain tumor
Glioproliferative lesion of spinal cord as a complication of cell therapy
Uncontrolled differentiation of implanted ESCs
Tumorigenicity of ESC-derived retinal progenitor cells
Clinical trials of cell therapy in neurological disorders
Future of cell therapy of CNS disorders

8. Ethical, Legal and Political Aspects of Cell therapy
Introduction
Political and ethical aspects of hESC research in the US
Ethical issues concerning fetal tissues
Morality and hESC research
Opponents of hESC research in the US
Use of hESCs in NIH-supported research
Politics of hESC research in the US
Public opinion in the US about hESC research
Human stem cell cloning in the US
Stem cell guidelines of various US institutions
Ethics of transplanting human NSCs into the brains of nonhuman primates
ESC lines available worldwide
ESC policies around the world
Countries with no defined policies on hESC research
Australia
Canada
China
Denmark
France
Germany
India
Ireland
Israel
Italy
Japan
Russia
The Netherlands
Saudi Arabia
Singapore
South Africa
South Korea
Spain
Sweden
Switzerland
United Kingdom
UK StemCellBank
European Union
EU guidelines for stem cell research
European stem cell bank
EMBO’s recommendations for stem cell research
Public opinion in Europe about hESC research
United Nations, cloning and nuclear transfer
The Embryo Project for information on ESC research
Concluding remarks about ethics of ESC research
Ethical issues concerning umbilical cord blood
Legal issues associated with stem cells
Stem cell patents
Stem cell patents in the United States
Current status of Thomson patents at WARF
Stem cell patents in the European Union
Cell therapy tourism

9. Safety and Regulatory Aspects of Cell Therapy
Introduction
Safety issues of cell therapy
Immune-mediated reactions to transplanted stem cells
Human virus infections associated with stem cell transplantation
Herpes simplex virus type 1
Cytomegalovirus
Opportunistic infections among hematopoietic stem cell transplant recipients
Cord colitis syndrome
Carcinogenic potential of stem cells and its prevention
Regulatory challenges for the clinical use of cell products
Prediction of in vivo performance of cell-based therapies
FDA safety regulations for cell and tissue products
FDA Guidance on license applications for umbilical cord blood products
Regulation of cord blood banks in the US
Regulatory issues for biotechnology-derived drugs
Regulation of products for adoptive cell therapy of cancer
Regulation of cell selection devices for PBSCs at point of care
FDA rules for human cells and tissues
FDA regulation of fetal cellular or tissue products
FDA and ESC lines
FDA and clinical trials using hESCs
Cell and gene therapy INDs placed on hold by the FDA
Regulatory issues for genetically engineered cell transplants
FDA guidelines for human tissue transplantation
FDA considers cultured stem cells for therapy as drugs
FDA perspective on safety-efficacy and risk-benefit of stem cell therapy
Xenotransplantation
Clinical Protocol Review and Oversight
Informed consent and patient education
Xenotransplantation product sources
FDA guidelines for xenografts
US regulations for manufacture of cell therapy products
GMP in USA
Regulations relevant to cell therapy in the European Union
Regulations about use of stem cells in the EU
Guidelines for cell therapy in the UK
Quality requirements for ex vivo-expanded MSC products for clinical use
European regulations for manufacture of cell therapy products
GMP in Europe
Global regulation of stem cell approval
Transport of stem cells between countries
Temperature limitations during transport of stem cells
NIH and stem cells
hESC lines approved under the new NIH guidelines
Clinical trials in cell therapy

Tables
Table 1-1: Landmarks in the history of cell therapy
Table 1-2: Examples of cells involved in various diseases
Table 2-1: Types of human cells used in cell therapy
Table 2-2: A selection of companies providing cell culture media
Table 2-3: A sampling of companies supplying cell sorters
Table 2-4: Companies involved in cell-based drug discovery
Table 2-5: Methods of delivery of cells for therapeutic purposes
Table 2-6: Therapeutic applications of encapsulated cells
Table 2-7: Companies working on encapsulated cell technology
Table 2-8: Molecular imaging methods for tracking cells in vivo
Table 3-1: Various levels of potency relevant to stem cells
Table 3-2: Clinical trials of UCB
Table 3-3: Companies involved in cord blood banking as a source of stem cells
Table 3-4: Comparison of techniques for nuclear reprogramming of stem cells
Table 3-5: Banks of patient-specific iPSC lines
Table 3-6: Companies providing iPSCs
Table 3-7: Sources of adult human stem cells
Table 3-8: Comparison of human stem cells according to derivation
Table 3-9: Enhancing engraftment, mobilization and expansion of stem cells
Table 3-10: Applications of stem cells
Table 3-11: Advantages and limitations of methods for optimizing MSCs
Table 3-12: Pharmaceutical manipulation of stem cells
Table 3-13: Growth factors with positive effects on stem cells and applications
Table 3-14: Examples of drugs that induce granulocytopenia at stem cell level
Table 3-15: Academic institutes involved in stem cell research
Table 3-16: Companies involved in stem cell technologies
Table 4-1: Therapeutic applications of regulatory T cells (Tregs)
Table 4-2: Various tissue/cell therapy approaches to the treatment of type 1 diabetes
Table 4-3: Companies involved in cell therapy for insulin-dependent diabetes
Table 4-4: Major pulmonary disorders potentially treatable by stem cell manipulation
Table 4-5: Cell-based repair of knee cartilage damage
Table 4-6: Intraoperative cell therapy
Table 5-1: Classification of various types of cell therapy for cardiovascular disorders
Table 5-2: Clinical trials of cell therapy in cardiovascular disease
Table 6-1: Cell therapy technologies used for cancer
Table 6-2: Companies involved in developing cell-based therapies for cancer
Table 7-1: Studies in rats or mice of in vivo reprogramming of cells for brain repair
Table 7-2: NSCs-based approaches for neurological disorders.
Table 7-3: Experimental use of immortalized cells for CNS disorders
Table 7-4: Combination of stem cells and HBO in models of neurological disorders
Table 7-5: Therapeutic applications of MSCs for neurological disorders
Table 7-6: Methods for delivering cell therapies in CNS disorders
Table 7-7: Neurological disorders amenable to cell therapy
Table 7-8: Types of cell used for investigative treatment of Parkinson's disease
Table 7-9: Status of cell therapies for Parkinson's disease
Table 7-10: Role of cell therapy in management of stroke according to stage
Table 7-11: Clinical trials of cell therapy for stroke: completed, ongoing and pending
Table 7-12: Clinical trials of cell therapy for retinal degenerative disorders
Table 7-13: Clinical trials with cell therapy in neurological disorders (excluding stroke)
Table 8-1: Listed numbers of ESC lines around the world
Table 8-2: Stem cell policies around the world
Table 8-3: European public attitudes about research involving human stem cells
Table 9-1: Possible adverse reactions and safety issues of cell therapy

Figures
Figure 1-1: Interrelationships of cell therapy to other technologies
Figure 1-2: Interrelationships of gene, cell and protein therapies
Figure 1-3: Engineering of RBCs for drug delivery
Figure 3-1: A simplified biological scheme of embryonic stem cells
Figure 3-2: Steps of iPS cell production
Figure 3-3: hESC-derived by somatic cell nuclear transfer
Figure 3-4: Flow chart of development of stem cells with potential bottlenecks
Figure 4-1: Reprograming ESCs/iPSCs cells to β-cells for type 1 diabetes
Figure 4-2: Fluorescently labeled polarized Upcyte® hepatocytes
Figure 5-1: Ex vivo vs in vivo approaches to regeneration of the heart
Figure 5-2: hESC-derived cardiomyocytes from laboratory to bedside
Figure 5-3: Steps in growing a new heart in vitro for transplantation
Figure 6-1: A scheme of generation and administration of tumor antigen-pulsed dendritic cells
Figure 6-2: Chimeric antigen receptor (CAR)-T cells attacking tumor cells
Figure 6-3: Stem cell transplantation techniques
Figure 7-1: Cell-based methods for repair of the brain
Figure 7-2: Reprogramming methods for in vivo generation of neurons.
Figure 7-3: Stem cells that can give rise to neurons
Figure 7-4: Sources of dopaminergic neurons for transplantation in Parkinson's disease
Figure 7-5: Scheme of iPSCs for personalized cell therapy of Parkinson disease
Figure 7-6: Potential mechanisms of stem cell efficacy in ALS
Figure 7-7: Approaches to stem cell therapy in stroke

Part II: Markets, Companies & Academic Institutions

10. Markets and Future Prospects for Cell Therapy
Introduction
Methods for estimation of cell therapy markets
Potential markets for cell therapy
Markets according to technologies
Stem cell transplants
Supporting cell technologies
Blood transfusion market
Cord blood collection and storage
Cell therapy and related technologies
Cell therapy markets according to therapeutic areas
Bone and joint disorders
Cancer
Cardiovascular disorders
Diabetes mellitus
Liver disorders
Neurological disorders
Retinal degenerative diseases market
Skin and wound care
Urinary incontinence
Reconstruction of teeth by stem cell implants
Market size according to geographical areas
Unmet market needs in cell therapy
Drivers of growth of cell therapy markets
Role of stem cells in regenerative medicine
Role of cells in markets for artificial organs
Increase of R&D expense on cell therapy
Increased used of cell-based drug discovery
Impact of emerging healthcare trends on cell therapy markets
Markets for cell therapy tourism
Involvement of pharmaceutical companies in cell therapy
Future prospects of cell therapy
Embryonic stem cell research around the world
Consortia for ESC research in Europe
EuroStemCell
FunGenES
ESTOOLS
UK National Stem Cell Network
Ethical concerns about commercialization of embryonic stem cells
Education of the physicians
Public education
NIH support of stem cell research
Funding of stem cell research from non-federal sources
Prospects of venture capital support for stem cell companies
Cell therapy in the developing countries
Guidelines for stem cell therapies
Business strategies
Formation of networks
Market potential of autologous vs allogeneic cells
Future market potential of adult vs embryonic stem cells
Transportation and handling of cell therapy products
Translating science into business

11. Companies Involved in Cell Therapy
Introduction
Profiles of selected companies
Collaborations

12. Academic Institutions
Introduction
Stem cell center
Profiles of institutions
Collaborations

13. References

Tables
Table 10-1: Market size according to cell therapy and related technologies 2016-2026
Table 10-2: Market size according to therapeutic areas for cell therapy in 2016-2026
Table 10-3: Cell therapy markets for cardiovascular disorders in 2016-2026
Table 10-4: Values of cell therapies for neurological disorders in 2016-2026
Table 10-5: Total cell therapy market in 2016-2026 according to geographical areas
Table 10-6: Cord blood market according to geographical areas 2016-2026
Table 10-7: Stem cells transplant market according to geographical areas 2016-2026
Table 10-8: SWOT Autologous cells vs allogeneic cells
Table 11-1: Publicly traded cell therapy companies
Table 11-2: Selected collaborations of cell therapy companies
Table 12-1: Therapeutic uses of stem cells
Table 12-2: Commercial collaborations of US academic institutes relevant to stem cells

Figures
Figure 10-1: Unmet needs in cell therapy
Ordering:

Order Online - http://www.researchandmarkets.com/reports/39071/

Order by Fax - using the form below

Order by Post - print the order form below and send to

Research and Markets,
Guinness Centre,
Taylors Lane,
Dublin 8,
Ireland.
Fax Order Form
To place an order via fax simply print this form, fill in the information below and fax the completed form to 646-607-1907 (from USA) or +353-1-481-1716 (from Rest of World). If you have any questions please visit http://www.researchandmarkets.com/contact/

Order Information
Please verify that the product information is correct and select the format(s) you require.

- Product Name: Cell Therapy - Technologies, Markets and Companies
- Web Address: http://www.researchandmarkets.com/reports/39071/
- Office Code: SCWPOK5Q

Product Formats
Please select the product formats and quantity you require:

<table>
<thead>
<tr>
<th>Quantity</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Electronic (PDF) - Single User:</td>
<td>USD 6000</td>
</tr>
<tr>
<td>Hard Copy:</td>
<td>USD 6500 + USD 56 Shipping/Handling</td>
</tr>
<tr>
<td>Electronic and Hard Copy (PDF) - Single User:</td>
<td>USD 7000 + USD 56 Shipping/Handling</td>
</tr>
<tr>
<td>Electronic (PDF) - Enterprisewide:</td>
<td>USD 18000</td>
</tr>
</tbody>
</table>

* Shipping/Handling is only charged once per order.
* The price quoted above is only valid for 30 days. Please submit your order within that time frame to avail of this price as all prices are subject to change.

Contact Information
Please enter all the information below in BLOCK CAPITALS

<table>
<thead>
<tr>
<th>Title:</th>
<th>Mr</th>
<th>Mrs</th>
<th>Dr</th>
<th>Miss</th>
<th>Ms</th>
<th>Prof</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Name:</td>
<td>______________________</td>
<td>Last Name:</td>
<td>______________________</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Email Address: *</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Job Title:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organisation:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Address:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>City:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Postal / Zip Code:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phone Number:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fax Number:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Please refrain from using free email accounts when ordering (e.g. Yahoo, Hotmail, AOL)
Payment Information

Please indicate the payment method you would like to use by selecting the appropriate box.

☐ Pay by credit card: You will receive an email with a link to a secure webpage to enter your credit card details.

☐ Pay by check: Please post the check, accompanied by this form, to:
Research and Markets,
Guinness Center,
Taylors Lane,
Dublin 8,
Ireland.

☐ Pay by wire transfer: Please transfer funds to:
Account number 833 130 83
Sort code 98-53-30
Swift code ULSBIE2D
IBAN number IE78ULSB98533083313083
Bank Address Ulster Bank,
27-35 Main Street,
Blackrock,
Co. Dublin,
Ireland.

If you have a Marketing Code please enter it below:

Marketing Code:

Please note that by ordering from Research and Markets you are agreeing to our Terms and Conditions at http://www.researchandmarkets.com/info/terms.asp

Please fax this form to:
(646) 607-1907 or (646) 964-6609 - From USA
+353-1-481-1716 or +353-1-653-1571 - From Rest of World