

# Stem Cell Complete Overview on Past, Present, future

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**Abstract:** In recent years, somatic cell medical aid has become a really promising and advanced research topic. The development of treatment strategies has elicited nice expectations. This paper may be a review targeted on the discovery of various stem cells and also the potential therapies supported these cells. The genesis of stem cells is followed by laboratory steps of controlled stem cell culturing and derivation. Internal control and cancer cell formation assays area unit vital procedures in assessing the properties of the stem cells tested. Derivation strategies and also the utilization of culturing media area unit crucial to line correct environmental conditions for controlled differentiation. Among many types of stem tissue applications, the employment of grapheme scaffolds and also the potential of living thing vesicle-based therapies need attention because of their versatility. The review is summarized by challenges that somatic cell medical aid should overcome to be accepted worldwide. a good style of potentialities makes this cutting-edge medical aid a turning purpose in fashionable medicine, providing hope for untreatable diseases.

**Keywords:** Stem cells, Differentiation, Pluripotency, Induced pluripotent somatic cell (iPSC), Teratoma formation assay, somatic cell derivation, Growth media, Tissue banks, Tissue transplantation

## INTRODUCTION

Stem cells area unit biological cells found altogether multicellular organisms that may divide (through mitosis) and differentiate into numerous specialised cell sorts and might selfrenew to supply additional stem cells. In mammals, there are two broad varieties of stem cells: embryonic stem cells, which are isolated from the inner cell mass of blast cysts, and adult stem cells, that area unit found in numerous tissues. In adult organisms, stem cells and ancestor cells act as a repair system for the body, replenishing adult tissues. In a developing embryo, stem cells will differentiate into all the specialised cells (these area unit known as Pluripotent cells), but also maintain the traditional turnover of regenerative organs, such as blood, skin, or viscous tissues [1,2]. Stem cells will currently be unnaturally full-grown and transformed into

specialized cell sorts with characteristics consistent with cells of varied tissues like muscles or nerves through cell culture. Highly plastic adult stem cells are routinely used in medical therapies. Stem cells can be taken from a variety of sources, including umbilical cord blood and bone marrow. Embryonic cell lines and autonomous embryonic stem cells generated through therapeutic cloning have also been proposed as promising candidates for future therapies [3,4].

## CLASSIFICATION

- Embryonic stem cells
- Adult stem cells
- Embryonic Stem cells

These stem cells square measure derived from a four or 5 day recent human embryo that within the blastula part of development .The embryos square measure typically extract that been created in IVF(in vitro fertilization) clinics wherever many eggs square measure fertilized in a very tube , however just one constituted into the woman .The reproduction begins once a males sperm fertilizes a females egg cell to create one cell called as cell the one cell then begins a serious of divisions forming a pair of,4,8,16 cells etc. when four to six days before implantation within the womb – this mass of cells is named a blastula consists of Associate in Nursing inner cell mass (embryo blast) and outer cell mass (trophoblast). The outer cell mass becomes a region of the placenta .The inner cell mass is that the cluster of cell that may differentiate to become all the structure of Associate in Nursing adult organism [5,6]. Embryonic Stem Cells Embryonic stem cells possess the capability to divide for long periods and retain their ability to create all cell sorts at intervals the organism. These ar termed pluripotent stem cells. the most effective celebrated style of pluripotent vegetative cell is that the one gift in embryos that helps babies grow at intervals the female internal reproductive organ. These cells kind at the blastocyst stage of development. A blastula may be a hollow ball of cells that's smaller than a pinhead. The embryonic stem cell lie at intervals this

ball of cells [7,8]. Techniques for Generating Embryonic vegetative cell Cultures Embryonic stem cells are fully grown within the laboratory using a

procedure referred to as cell culture. The human embryonic stem cells are first isolated by removing the

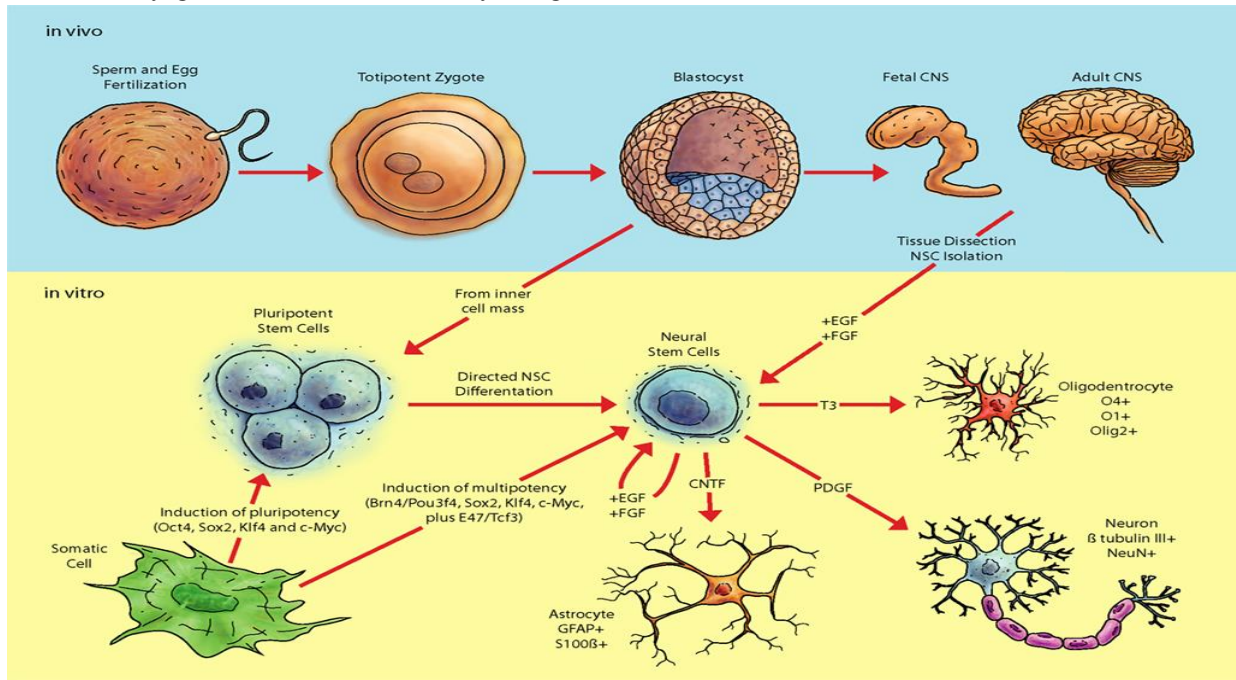


Fig 1 :Diagram showing stem cell growth in embryonic stage and production of different cell from stem cell

inner cell mass into a plastic laboratory culture dish that contains a nutrient medium or broth referred to as the substance. Kept at suitable temperature and witness the cells divide and spread over the surface of the dish. generally mouse embryonic skin cells coat the inner lining of the culture dish so they won't divide. this can be referred to as the feeder layer. This layer provides a sticky surface to the human embryonic stem cells to connect to. These feeder cells conjointly unleash nutrients into the substance. New techniques are devised to avoid these feeder cells for the chance of viruses or different macromolecules that will be transmitted from mouse to humans [9,10]. Over many days the cells of the inner cell mass proliferate and canopy the culture dish. they're then removed gently and transplanted onto many contemporary culture dishes. this can be perennial for several times and for several months and is termed sub culturing. every cycle of sub culturing the cells is brought up as a passage. After 6 months of sub culturing the first thirty cells of the inner cell mass will yield countless embryonic stem cells. Since these embryonic stem cells have proliferated in cell culture for six or a lot of months while not differentiating they're termed pluripotent cells. they're genetically traditional and are currently

referred to as embryonic vegetative cell line. Once the road is established batches of the cells are frozen and shipped to other laboratories for more culture and experimentation [11-15].

#### Adult Stem cells

Adult Stem Cells also are referred to as as physical cells exist throughout the body when embryonic development and are also found within differing types of tissues. These Stem Cells are found in tissues like brain, blood, blood vessels, skeletal muscles, skin and also the liver. they continue to be non dividing state for years till activated by unwellness or tissue injury [16,17].

#### Stem Cell Culture

When extracting embryonic vegetative cell. the blastocyst stage signals once to isolate vegetative cell by placing the "inner cell mass" of blastula into a culture dish containing a nutrient made broth. lacking the necessary stimulation to differentiate, they begin to divided and replicate whereas maintaining their ability to become any cell sort in physical structure there undifferentiated cell will be stirred to make specialized cell. Human embryonic vegetative cell colony either extracted from adult tissue or from a dividing fertilized ovum in an exceedingly culture dish. once extracted

,scientists place the cells in an exceedingly controlled culture that prohibits them from more specializing .the process of growing giant numbers of embryonic stem cells has been easier growing giant numbers of adult stem cells ,but progress is being created for each cell varieties [20,21].

**Properties**

The classical definition of a vegetative cell needs that it possess 2 properties:

**Self-renewal:** the power to travel through various cycles of cellular division whereas maintaining the dedifferentiated state.

**Potency:** the capability to differentiate into specialised cell types. within the strictest sense, this needs stem cells to be either ability or Pluripotent to be able to bring about to any mature cell sort, though multi potent or unipotent progenitor cells are typically noted as stem cells .Apart from this it's being aforesaid that stem cells perform is regulated in an exceedingly feedback mechanism [22,23].

**Self-renewal**

Two mechanisms to confirm that the vegetative cell population is maintained exist:

1. Obligatory uneven replication: a vegetative cell divides into one father cell that's a twin of the first vegetative cell, and another cell that's differentiated
2. random differentiation: once one vegetative cell develops into 2 differentiated girl cells, another

vegetative cell undergoes cell division and produces 2 stem cells a twin of the original.

**Cell potency:**

efficiency specifies the differentiation potential (the potential to totally differentiate into different cell types) of the vegetative cell [24-26].

**Totipotent:**

stem cells will differentiate into embryonic and extra cell varieties. Such cells will construct a complete, viable organism. These cells ar made from the fusion of and egg and spermatozoon. Cells made by the first few divisions of the animate being are ability.

**Pluripotent:**

stem cells ar the descendants of ability cells and may differentiate into nearly all cells i.e. cells derived from any of the 3 germ layers.

**Multipotent:**

stem cells will differentiate into variety of cells, however solely those of a closely connected family of cells.

**Oligopotent:**

stem cells will differentiate into solely a couple of cells, like humor or myeloid stem cells.

**Unipotent:**

cells will manufacture just one cell sort, their own, but have the property of self-renewal, that distinguishes them from non-stem cells (e.g., muscle stem cells).

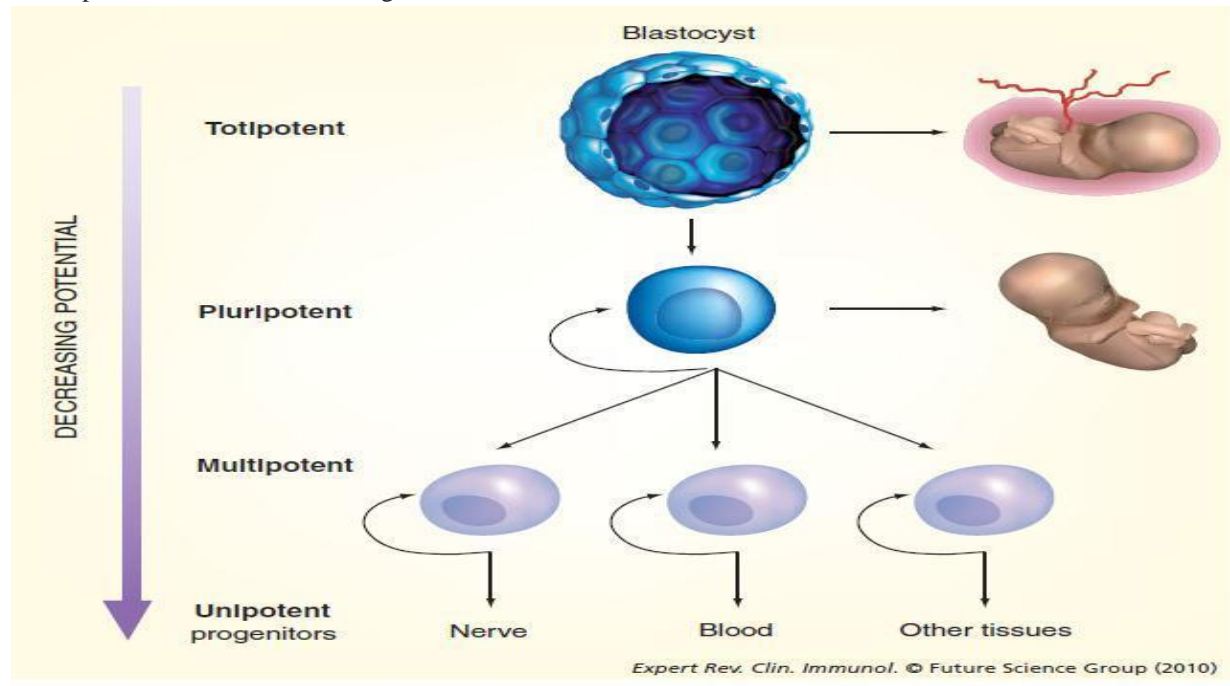


Fig2:- Diagram showing potential as key factor for regeneration of new tissue from different cell

How area unit stem cells ready and administered:

The process is as follows [27,28].

Step 1: Before gathering the fat (fat)tissue it's essential that sterilised canister is employed and crammed with 500ml of laundry answer.

Step 2: so as to organize plasma, blood is collected from the patient.

Step 3: fat tissues is then harvested from the patient via unhealthy liposuction step

4: The fat collected is then transferred into the falcon tubes then place into 37c shaking water tub.

Step 5: These tubes area unit then centrifuged

Step 6: when the centrifuging method, a vegetative cell pallet can form on all-time low of every falcon tube employing a measuring system and taking additional care not the stir contains, the pallets area unit then rigorously aloof from every tube.

Step 7: The pallets area unit then 1st filtered.

Step 8: by employing a syringe, we tend to collect the sample from the tube for cell enumeration and marking for viability.

Step 9: The remaining stem cells area unit the activated by victimization daylight.

Step 10: The cells area unit then administered back to the patient through one or additional of the subsequent modes of administration Intravenous: Administered through a typical intra blood vessel drip

Injected: Administered directly into a localised area.

#### Stem cell treatments

Order to treat sickness or injury. several medical researchers believe that somatic cell treatments have the potential to vary the face of human sickness and alleviate suffering. the flexibility of stem cells to self-renew and provides rise to consequent generations with variable degrees of differentiation capacities. Offers important potential for generation of tissues that may doubtless replace pathological and broken areas [28,29].

#### Stem cell treatments

Are a sort of intervention strategy that introduces new cells into broken tissue within the body, with stripped-down risk of rejection and facet effects. Medical researchers anticipate that adult and embryonic stem cells can before long be ready to treat cancer, Type 1 DM, Parkinson's syndrome, Huntington's disease, upset, viscous failure, muscle harm and neurological disorders, and lots of others.[3] notwithstanding,

before somatic cell medical specialty may be applied within the clinical setting, a lot of analysis is important to grasp somatic cell behavior upon transplantation moreover because the mechanisms of somatic cell interaction with the diseased/injured [30].

#### Hematopoietic somatic cell transplantation

Umbilical cord blood stem cells are wont to treat cancer patients with conditions like leukemia and lymphoma [4]. Throughout therapy, most growing cells are killed by the cytotoxic agents. These agents, however, cannot discriminate between the leukemia or euplastic cells, and also the hemopoietic stem cells inside the bone marrow. it's this facet impact of standard therapy strategies that the somatic cell transplant tries to reverse; a donor's healthy bone marrow reintroduces practical stem cells to interchange the cells lost within the host's body throughout treatment.

#### Potential treatment

##### Brain harm

Stroke and traumatic brain injury result in cell death, characterised by a loss of neurons and oligodendrocytes inside the brain. Healthy adult brains contain neural stem cells that divide to keep up general stem cell numbers or become ancestor cells. In healthy adult animals, ancestor cells migrate inside the brain and function primarily to keep up nerve cell populations for olfaction (the sense of smell). curiously, in gestation and when injury, this technique seems to be regulated by growth factors and might increase the speed at that new brain matter is created. though the reparative method seems to initiate following trauma to the brain, substantial recovery isn't determined in adults, suggesting an absence of robustness.[5,6] Stem cells might also be wont to treat brain degeneration, such as in shaking palsy and Alzheimer's disease

##### Cancer

Using typical techniques, brain cancer is difficult to treat as a result of it spreads thus speedily. Transplanted human neural stem cells into the brain of rodents that received intracranial tumours. inside days, the cells migrated into the cancerous space and created C demines. associate degree protein that converts a non-toxic pro-drug into a chemotherapeutical agent. As a result, the injected substance was able to scale

back the tumours mass by eighty one percent. the patient's own lymphocytes, and stem cells injected, eventually commutation the system of the patient therewith of the healthy donor.

#### Spinal cord injury:

Transplanted Multipoten adult stem cells from umbilical cord blood to a patient full of a spinal cord injury which following the procedure, she could walk on her own, effortlessly. The patient had not been able to rise up for roughly nineteen years. For the unprecedented trial, the scientists isolated adult stem cells from canal blood and so injected them into the broken a part of the funiculus. Transplanted Multipoten human foetal-derived neural stem cells into unfit mice, leading to locomotors enhancements four months later. The ascertained recovery was related to differentiation of transplanted cells into new neurons and oligodendrocytes- the latter of which forms the sheath around axons of the central nervous system, so insulating neural impulses and facilitating communication with the brain. Differentiated human blastodermic vesicle stem cells into neural stem cells, then into pre-mature motor neurons, and finally into spinal motor neurons, the cell kind that, in the human body, transmits messages from the brain to the spinal cord and later mediates motor operate in the fringe. The freshly generated motor neurons exhibited electrical activity, the signature action of neurons.

#### Heart injury

Several clinical trials targeting cardiovascular disease have shown that adult somatic cell medical care is safe, effective, and equally economical in treating previous and up to date infarcts. Adult stem cell medical care for treating cardiovascular disease was commercially accessible in a minimum of 5 continents at the last count. Possible mechanisms of recovery include: Generation of muscular tissue cells • Stimulation of growth of latest blood vessels to • repopulate broken heart tissue Secretion of growth factors • Assistance via another mechanism It may be potential to own adult bone marrow cells differentiate into muscular tissue stem cells.

#### Haematopoiesis (blood cell formation)

The system is at risk of degradation upon the pathologic process of malady, and since of the crucial

role that it plays in overall defence, its degradation is commonly fatal to the organism as a full. Diseases of biological process cells square measure known as hematopathology. The specificity of the immune cells is what permits recognition of foreign antigens, inflicting more challenges within the treatment of immune malady. Identical matches between donor and recipient should be created for made transplantation treatments, however, matches square measure uncommon, even between firstdegree relatives. analysis mistreatment each biological process adult stem cells and embryonic stem cells has provided insight into the potential mechanisms and strategies of treatment for many of those ailments. Potential advantages to sequence medical care, blood transfusion, and topical drugs [14].

#### Baldness

Hair follicles additionally contain stem cells, and some researchers predict analysis on these vesicle stem cells might lead to successes in treating phalacroscrosis through associate degree activation of the stem cells primogenerator cells. This treatment is predicted to work by activating already existing stem cells on the scalp. Later treatments could also be able to merely signal vesicle stem cells to relinquish off chemical signals to near vesicle cells that have contracted throughout the aging method, which in turn reply to these signals by create and once again creating healthy hair [31].

#### Missing teeth

This technology will be accustomed grow live teeth in human patients Stem cells taken from the patient might be coaxed within the research laboratory into turning into a tooth bud that, when implanted within the gums, can create to a brand-new tooth, and would be expected to grow inside 2 months. it'll fuse with the jawbone and unharnessed chemicals that encourage nerves and blood vessels to attach with it. the method is similar to what happens once humans grow their original adult teeth.

#### Deafness

Heller has according to success in re-growing tube hair cells with the employment of embryonic stem cells.

#### Blindness and vision impairment

Transplanted tissue layer stem cells into broken eyes to restore vision. "Sheets of retinal cells employed by

the team are harvested from aborted fetuses, that some individuals find objectionable." once these sheets square measure transplanted over the broken tissue layer, the stem cells stimulate revived repair, eventually restore [32].

#### Graft vs. host malady and Cohn's malady

Therapeutics mistreatment their in-development product Parochial, derived from adult bone marrow. The target disorders of this therapeutic square measure graft-versus-host disease and Cohn's malady.

#### Trials Neural and activity birth defects

Before they die the neural stem cells reach inducing the host brain to provide giant numbers of stem cells that repair the harm. currently developing procedures to administer the neural stem cells within the least invasive method possible - in all probability via blood vessels, creating medical care practical and clinically possible. Researchers conjointly commit to work on developing strategies to require cells from the patient's own body, flip them into stem cells, and so transplant them back to the patient's blood via the blood stream [25- 27].

#### Diabetes

Diabetes patients lose the perform of insulin producing beta cells at intervals the exocrine gland. Human embryonic stem cells could also be grownup in cell culture and aroused to form insulin-producing cells that may be transplanted into the patient.

#### Orthopedics

Clinical case reports within the treatment of orthopedic conditions are reportable. To date, the focus within the literature for contractile organ care seems to be on mesenchymal stem cells. subunit et al. have printed MRI proof of inflated animal tissue and gristle volume in individual human subjects. The results of trials that include an outsized range of subjects square measure nonetheless to be printed. However, a broadcast safety study conducted in a very cluster of 227 patients over a 3–4-year amount shows adequate safety and marginal complications related to mesenchymal cell transplantation mesenchymal stem cells with coverage of the treated chondral defects.

#### Wound healing

Stem cells can even be accustomed stimulate the expansion of human tissues. In AN adult, wounded

tissue is most frequently replaced by connective tissue, that is characterised within the skin by snafu albuminoid structure, loss of hair follicles and irregular body structure. within the case of wounded foetal tissue, however, wounded tissue is replaced with traditional tissue through the activity of stem cells. A attainable methodology for tissue regeneration in adults is to put adult somatic cell "seeds" within a tissue bed "soil" in a very wound bed and permit the stem cells to stimulate differentiation within the tissue bed cells. This methodology elicits a regenerative response additional similar to foetal wound-healing than adult connective tissue formation.

#### Infertility

Culture of human embryonic stem cells in mitotic ally inactivated porcine gonad fibroblasts (POF) causes differentiation into germ cells (precursor cells of coyotes and spermatozoa), as proved by organic phenomenon analysis

#### Stem cells use in animals

##### Veterinary applications

##### Potential contributions to medical specialty

Horses, dogs, and cats will profit the event of stem-cell treatments in medical specialty and might target a good vary of injuries and diseases like myocardial infarct, stroke, sinew and ligament harm, osteoarthritis, osteochondrosis and genetic defect each in massive animals, similarly as humans. Companion animals can function clinically relevant models that closely mimic human sickness.

Development of regenerative treatment models Veterinary applications of somatic cell medical aid as a means of tissue regeneration are with the utilization of adult-derived mesenchymal stem cells to treat animals with injuries or defects moving bone, cartilage, ligaments or tendons. as a result of mesenchymal stem cells will differentiate into the cells that form up bone, cartilage, tendons, and ligaments (as well as muscle, fat, and probably different tissues), the treatment of diseases moving these tissues. Mesenchymal stem cells square measure primarily derived from fat tissue or bone marrow. Since AN elevated response following cell transplantation could end in rejection of exogenous cells (except within the case of cells derived from a very closely genetically connected individual), mesenchymal stem cells square measure typically derived from the patient before

injection in an exceedingly method called autologous transplantation. Surgical repair of bone fractures in dogs and sheep has demonstrated that engraftment of mesenchymal stem cells derived from a genetically completely different donor among an equivalent species, termed matter transplantation, doesn't elicit AN immunological response within the recipient animal and might mediate regeneration of bone tissue in major bony fractures and defects [27]. Stem cells will speed up bone repair in fractures or defects that will commonly need in depth grafting, suggesting that mesenchymal somatic cell use could provide a helpful different to traditional affixation techniques. Treating sinew and ligament injuries in horses using stem cells, whether or not derived from fat or bone-marrow, has support within the veterinary literature[51][52]. While additional studies square measure necessary to totally characterize the use of cell-based medicine for treatment of bone fractures, stem cells square measure thought to mediate repair

Currently out there treatments for horses and dogs suffering from orthopedic conditions

Autologous or substance stem cells square measure presently used as AN connected medical care within the surgical repair of some types of fractures in dogs and horses. autologous stem cellbased treatments for ligament injury, sinew injury, osteoarthritis, osteochondrosis, and sub-chondral bone cysts have been commercially out there to active veterinarians to treat horses since 2003 within the u. s. and since 2006 within the uk. autologous stemcell injury and arthritis in dogs, horses and dogs have been treated with autologous adipose-derived stem cells. The effectualness of those treatments has been shown in double blind clinical trials for dogs with arthritis of the hip and elbow and horses with sinew harm. The effectualness of using stem cells, whether or not adipose-derive [31].

Advantages and downsides of adult stem cells over embryonic stem / germ cells

Adult-derived somatic cell therapies can complement; however, they cannot replace, therapies that will be obtained from embryonic stem cells. Still, they are doing have some benefits. For example-adult stem cells provide the opportunity to utilize little samples of adult tissues, to obtain AN initial culture of a patient's own cells for expansion and ulterior implantation

within the same person (that is named AN autologous transplant). This method avoids immune rejection by the recipient and conjointly protects the patients from infective agent, microorganism or different contamination from another individual (donor) just in case of substance transplant. With correct internal control and testing, allergenic adult stem cells is also sensible in addition. Autologous and substance transplants of organic process stem cells (discussed ahead) that square measure isolated from mobilized peripheral blood .or kind bone marrow by positive choice with antibiotics square measure in clinical use. Additionally, since they commonly differentiate into a narrow set of cell sorts, directive them to a desired fate is easier.

One major disadvantage

is that culturing adult stem cells in-vitro is extremely troublesome and has not benefits of Stem Cell analysis [32].

It provides medical advantages within the fields of therapeutic cloning and regenerative drugs.

It provides nice potential for locating treatments and cures to a overplus of diseases as well as Parkinson's disease, schizophrenic disorder, Alzheimers, cancer, spinal cord injuries, polygenic disease and plenty of additional.

Limbs and organs can be full-grown during a workplace from stem cells and so employed in transplants or to assist treat sicknesses. it'll facilitate scientists to find out regarding human growth and cell development.

Scientists and doctors are ready to check scores of potential medicine and drugs, while not the utilization of animals or human testers.

This necessitates a method of simulating the effect the drug has on a particular population of cells. This would tell if the drug is beneficial or has any issues. somatic cell analysis conjointly advantages the study of development stages that can't be studied directly during a human embryo, that typically square measure connected with major clinical consequences like birth defects, pregnancy-loss and sterility.

A additional comprehensive understanding of normal development can ultimately enable the interference or treatment of abnormal human development. Another advantage of somatic cell analysis is that it hold the key to reversing the consequences of aging and prolonging our lives. vegetative cell analysis has

already found several treatments that facilitate in deceleration the aging method, and a bonus of further vegetative cell analysis may be a doable 'cure' for aging altogether.

A plus of the usage of adult stem cells to treat disease is that a patient's own cells might be accustomed treat a patient.

Risks would be quite reduced as a result of patients' bodies wouldn't reject their own cells. Embryonic stem cells will be converted into any cell sorts of the body and will then be a lot of versatile than adult stem cells.

**Disadvantages of vegetative cell analysis**

The employment of embryonic stem cells for analysis involves the destruction of blast cysts fashioned from laboratory fertilized human eggs. For those people that believe that life begins at conception, the blastula may be a human life and to destroy it's immoral and unacceptable. like every alternative new technology, it's conjointly utterly unknown what the long effects of such associate interference with nature may pass. Embryonic stem cells might not be the answer for all ailments. in line with a brand new analysis, vegetative cell medical care was used on cardiopathy patients. it had been found that it will create their coronary arteries narrower. an obstacle of most adult stem cells is that they're pre-specialized, as an example, blood stem cells create solely blood, and brain stem cells create solely brain cells. These ar derived from embryos that don't seem to be a patient's own and also the patient's body could reject them.

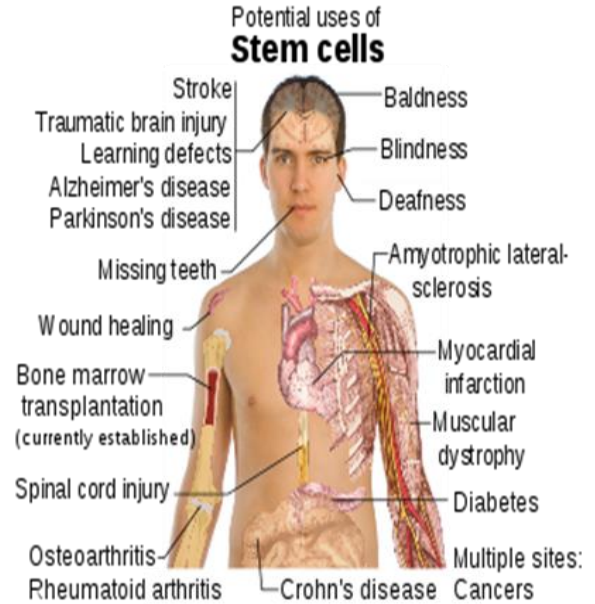
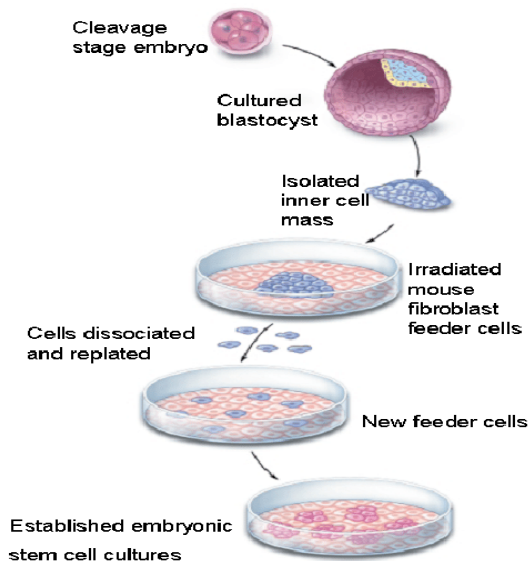


Fig3-Diagram showing Embryonic Stem Cell Culture in Laboratories Fig4-Diagram showing potential use of stem cell

**CONCLUSION**

Stem cells may be used totally different areas. Such as Current treatments, Potential treatments, Brain harm, Cancer, medulla spinalis injury, Heart harm, hematogenesis (blood cell formation) hairlessness, Missing teeth, Deafness, Blindness and vision impairment, Amyotrophic lateral sclerosis, Graft vs. host sickness and Cohn's sickness, Neural and behavioral birth defects, Diabetes, orthopedics, Wound healing, sterility, Clinical Trials, vegetative cell use in animals, Veterinary applications, Potential contributions to veterinary medication, Development of regenerative treatment models, Significance of vegetative cell microenvironments. there's no cyanogenic result and adverse reactions compare to the therapy, radiation therapy.

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