TECHNOLOGY NETWORKS

STEM CELLS IN REGENERATIVE MEDICINE

PROGRESS, CHALLENGES AND THE FUTURE

Regenerative medicine is the collection of tools and methods which "replaces or regenerates human cells, tissues or organs, to restore or establish normal function".[1]

TISSUE ENGINEERING & BIOMATERIALS

STEM CELLS

ARTIFICIAL ORGANS

The promise of using human stem cells for regenerative medicine began in the 1950's, with the first successful bone marrow transplant conducted in 1956 by Dr E. Donnall Thomas.[2]

SINCE THEN, STEM CELL RESEARCH HAS EXPANDED DRAMATICALLY.

1961 Multipotent stem cells discovered by Till and McCulloch.[3]

1981 Isolation of embryonic stem cells in mice by Evans and Kaufman.[4]

1996 Dolly the sheep cloned.[5]

1998 Isolation of human embryonic stem cells by Thomson.[6]

2006 Development of induced pluripotent stem cells in mice by Yamanaka.[7]

2007 Human induced pluripotent stem cells created.[8]

2007 Induced pluripotent stem cells treat mouse model of sickle cell anemia.[9]

2010 Person with spinal injury receives first human embryonic stem cell derived treatment.[10]

2012 Damaged mouse hearts regenerated by reprogramming.[11]

2013 Human embryonic stem cells created from fetal cells using therapeutic cloning.[12]

2014 Human embryonic stem cells created from adult cells using therapeutic cloning.[13]

2014 First induced pluripotent stem cell trial.[14]

2016 Ding developed method for reprogramming without genetic manipulation.[15]

Despite its great potential, so far there has been limited success translating stem cell-based regenerative therapies into the clinic.[16]

Cost
Manufacturing needs to be economically viable for adoption by healthcare providers

Scalability
Billions of cells may be needed per patient

Reproducibility
All cells must be the same at the end of manufacturing

Regulation
Cells must not have been exposed to animal-derived products

Delivery
Cells must reach the desired location in the body

Ethical issues
ESC use is controversial

Safety
Avoidance of unwanted side effects such as risk of tumor formation

Choosing the right cell culture media can help address some of the challenges of culturing and expanding therapy-worthy cells, by ensuring that cells are grown in a robust, clinically acceptable, and reproducible manner.

Changes in regulation, such as the FDA's Regenerative Medicine Advanced Therapy Designation could help push forward the development of stem cell-based therapies for serious and life-threatening conditions.[17]

THE NEED FOR REGENERATIVE MEDICINE

Every
10 minutes
someone is added to the organ transplant waiting list[18]

735,000
Americans have heart attacks a year[19]

Globally
1 in 11
adults are living with diabetes[20]

17%
of the world's population will be over 65 years of age by 2050[21]

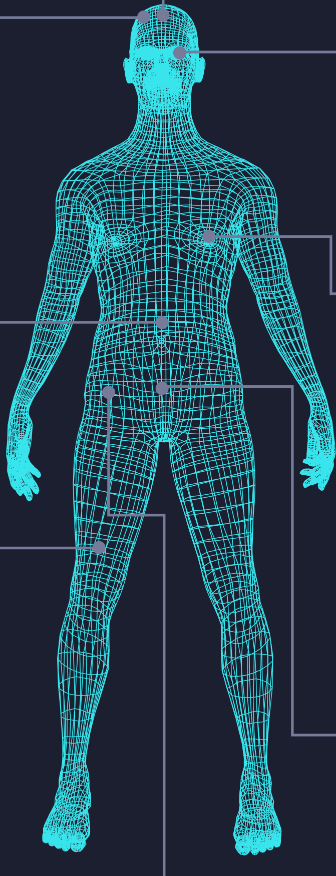
LOOKING TO THE FUTURE

Current stem cell research and pilot studies are paving the way for future regenerative medicine options for many diseases.

Amyotrophic Lateral Sclerosis (ALS)
MSCs are being used in clinical trials to treat ALS patients.

Parkinson's Disease
Dopaminergic neurons that can replace cells lost in Parkinson's patients in development.

Age-related Macular Degeneration
Clinical study implants retinal eyepatches created from stem-cell derived ocular cells into patients.



Pancreatic Stem Cells
Progenitor cells in the human pancreas identified, which have potential to regenerate beta cells.

Beating Heart Patch
Created from hPSCs, the patches could offer a way to replace muscle lost from heart attacks.

Muscle Regeneration
Mature skin cells directly reprogrammed into immature muscle cells in mice.

Colonic Organoids
Human embryonic colonic organoids successfully tissue engineered, could lead to development of GI tract tissues for transplant.

Functioning Kidney Tissue
Functioning nephrons produced by implanting hPSCs into mice.

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