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The Gravity of Regenerative Medicine; Physics, Chemistry & Biology behind it

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The in-vitro expansion of cells of the organs/tissues and their re-implantation into the affected region/ tissue for treating cell/organ failure have been in practice for long, but in limited specialties. The in-vitro cell culture protocols use variety of biological reagents derived from animal sources and recombinant technologies. However, the optimal quantity of such biological components such as growth factors, cytokines etc., needed for such cells to be grown in a non-physiological environment is still unknown. The use of such biological components have started to stir a controversy of late, due to the recognition of its potential hazards such as spread of prion diseases and contamination with non-human sialic acid proteins. Therefore synthetic reproducible biomaterials are gaining popularity in cell culture and tissue engineering.

The biomaterials made of several chemical components based on physical parameters are

starting to change certain concepts about the niche of cell culture and that of stem cell expansion and differentiation to specific lineages. Engler et al have already proven that a simple change in the matrix elasticity alone could change the lineage of the cells. Spencer et al have reported that a change in bioelectricity could change the morphogenesis during development.

NCRM has been involved in cell culture and tissue engineering using approximately 240 different materials ranging from polymer hydrogel, gel with adherent inserts, nano composite materials, nano-coating technologies, nano-sheets and nano-films. These materials are used in cell culture in different hybrid combinations such as

1. Floating 3D cell culture without adherent components in a homogenous hydrogel.
2. Floating 3D cell culture with anchorage inserts.
3. Flat surface- 2D adherent cell culture.

4. Combined flat surface 2D cell culture (for differentiating cells) and floating 3D culture (for undifferentiated cells).

These combinations have started yielding several advantages in Corneal epithelial stem cells, Corneal endothelial precursors, Chondrocytes, Mouse Embryonic Stem Cells, Mouse Embryoid bodies.

Expansion of undifferentiated naive and Embryonic Stem (ES) cells has been made possible employing such hybrid techniques. With similar hybrid techniques we hope to make the undifferentiated expansion of fundamental hematopoietic stem cells possible. Nijnik et al have reported that the HSCs undergo damage with aging. If such in-vitro expansion technology without biological contamination could be made available in large scale, the day is not far off, when cryopreservation of one's own hematopoietic stem cells harvested in youth can be cryopreserved and expanded and injected after a decade or two. If this becomes a reality, it would be the first step towards a physiological rejuvenation/infusion of youth and prolongation of the lifespan.

Physical parameters of such chemically constituted and reproducible hybrid scaffolds need to be studied in detail. We need to explore whether variability in these physical and chemical parameters would differentially influence the biological differentiation of cells. If this were to occur by simply manipulating either the physical or the chemical characteristics of these scaffolds, the cell of our choice can be obtained and used for treating varied human diseases affecting different cell types and organs.

The effect of all physical parameters on biological differentiation can be studied on earth, with an exception of the effect of gravity. If differential physical parameters allow varied biological differentiation, the day is not too far, when people will be sending space ships carrying their cells with automated systems to the outer space of lesser or zero gravity to get the cells of their choice expanded and the same be brought

back after culture in outer space to be injected as a treatment modality.

Different planets with differing gravities could induce growth of different lineage of cells with different capabilities. This may herald the birth of a new scientific discipline called Astro-regenerative medicine and NCRM at that point would establish NGRM (Nichi-In Galaxy of Regenerative Medicine).