RESEARCH NOTE International Journal of Medical Sciences (April & October, 2011) Vol. 4 Issue 1& 2 : 58-59

Microgravity in Tissue Engineering: Unique Properties in Promoting Three Dimensional Growth and Assembly of Cells into Functional Tissues, The Next Future of Pharmacotoxicology and Food Research

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ABSTRACT

Microgravity-derived 3-D cell constructs and tissue engineering may provide, for the future, useful tools for generating reliable model systems that couple cheapness and handiness with an increased predictive power, also fostering the integration process of data from genomics, proteomics, metabolic profiling and molecular cell biology. "Exploiting the third dimension" is a big challenge for the next decades in life sciences and will require a more complete integration of systems biology approaches into the design and analysis of engineered tissues. The rapid progress in the development of the new micro- and nano-technologies, together with the improvements in imaging technologies and in the establishment of standard experimental protocols, will certainly enhance the possibility of a rapid advance toward this objective.

Purushothaman, A., Meenatchi, P. and Shahjahan , M. (2011). Microgravity in Tissue Engineering: Unique Properties in Promoting Three Dimensional Growth and Assembly of Cells into Functional Tissues, The Next Future of Pharmacotoxicology and Food Research *Indian J. Med. Sci.,* **4**(1 &2):58-59.

Key words :
Rotating Wall Vessel (RWV) bioreactors, Microgravity, Tissue engineering

Received :
April, 2011
Accepted :
August, 2011

Life on earth developed in the presence and under the constant influence of gravity. Gravity has been present during the entire evolution, from the first organic molecule to mammals and humans. Modern research revealed clearly that gravity is important, probably indispensable for the function of living systems, from unicellular organisms to men. Thus, understanding the impact of gravity on cellular functions on earth will provide not only important information about the development of life on earth, but also for therapeutic and preventive strategies to cope successfully with medical problems during space exploration.

Treatment for organ-loss and tissue-loss problems due to disease and accidents costs in excess of $400 billion a year. In transplantation, there are tremendous shortages of the various tissues and organs. In the case of liver transplants, donor organs currently satisfy less than 25 per cent of the organs needed for individuals in end-stage liver failure. The figures are slightly better for kidneys, but again we do not meet the full demand. All kidneys that are deemed suitable go to individuals in renal failure. Therefore, researchers are looking for alternative sources of tissue. One source is tissue engineering. If we can go from cells to tissue, ultimately we can engineer that tissue to become a transplantable organ.

Microgravity: Tissue engineering:

Most commonly, cell culture is performed in two-dimensions, such as in Petri dishes, tissue culture flasks or multi-well plates (Freshney, 1994). In spite of the tremendous amount of information gained in traditional cell culture settings, it is generally acknowledged that conventional tissue culture in two dimensions may be inadequate to model the complex cellular interactions that promote tissue-specific differentiation as they occur during organogenesis (Bell, 1991; Kloth *et al.,* 1995).

Some of these inadequacies of tissue assembly in conventional two-dimensional culture or in traditional bioreactors have recently been overcome by the development of the NASA rotating wall vessel (RWV) bioreactors. The introduction of RWV cell