Editorial

Current Biotechnology in Space

Over the last decades, space research has been considered a promising field of study with significant contribution to the development of science and technology. With the advent of commercial space ventures, several new space applications may be on the horizon, including the development of novel medical, biological and environmental products. In this context, the outer space can be used as a natural environment to investigate complicated and still obscure biological process from a new perspective not available to earth-bound laboratories. This unique research environment introduces a new opportunity to explore and develop unconventional life science techniques. Current biotechnology research in space focuses on protein crystallization, cell tissue engineering, pharmacological and medical applications as well as on the development of technologies to support life science studies in space. Such endeavor has the potential to inaugurate a new era in biotechnological studies. In view of the exciting advances in the field, this special issue presents the recent breakthroughs in space biotechnology with a collection of reviews and original research papers covering interesting themes on basic and applied biotechnology.

In the first paper, Schuber *et al*. (2013) summarize the current status of the BIOLAB facility, the ESA multi-user facility accommodated in the European 2 COLUMBUS Module of the International Space Station to perform biological and biomedical experiments in space. Donoviel and Sutton (2013) describe some of the promising technologies developed for space that have also found terrestrial applications and are being commercialized with the help of the National Space Biomedical Research Institute [2]. Since these technologies are largely non-invasive and have a small footprint, they could be used by low-cost healthcare providers in non-traditional settings outside hospitals and clinics. Walther *et al*. (2013) highlight the recent progress on microgravity cell culture systems with focus in two bioreactors: the "PADIAC" hardware (designed for the cultivation, activation, and fixation of human immune cells in space) and the "YEAST BIOREACTOR" (designed for the cultivation of yeast cells under microgravity conditions) [3]. Yumi and Yuge (2013) review the recent progress in expansion and differentiation of stem cells grown under simulated microgravity environment using a new 3D-clinostat as a powerful approach and their utility for stem cell-based therapy applications [4]. Bartsev (2013) discusses different problems and criteria for the optimal design of biological Life Support Systems (LSS), integrating major observations from experimental approaches and theoretical considerations developed in previous studies [5]. Hesenstein and Scherp (2013) discuss the potential use of Solid Phase Gene Extraction (SPGE) technique for sampling biological material under space conditions [6]. Anken (2013) provides an overview of the most frequently used microgravity simulators and demonstrate their individual capacities and limitations [7]. Buravkova *et al*. (2013) describe the studies on osteogenic, osteoblastic, and mesenchymal stem cells to real and simulated microgravity [8]. In particular, the authors have focused on key signaling pathways and gene expression changes in these cells that occur after exposure to experimental and real microgravity. Divieti-Pajevic *et al*. (2013) highlight the current findings and future challenges of studying osteocyte in relationship to space flight and discuss their significance in the understanding of skeletal mechano-transduction [9]. Cialdai and Monici (2013) review the recent studies regarding the effects of weightlessness on wound healing, in particular focusing on the behavior of cells involved in the remodelling phase of repair [10]. The findings of these studies, considered in the broader context of future clinical applications, might be useful also to improve biotechnologies for tissue regeneration and engineering. Higashibata *et al*. (2013) present their results performed in space flight experiments with the aim to identify proteins in the model species *Caenorhabditis elegans* that were up-or down-regulated during space flight [11]. Willaert (2013) reports the growth behavior of the model eukaryotic yeast *Saccharomyces cerevisiae* in microgravity [12], and in the last paper, Karoliussen *et al*. (2013) summarize spaceflight studies on plant biology [13].

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