ISSN: 2319-9873

Research and Reviews: Journal of Engineering and Technology

Bioengineering: A Perfect Amalgamation of Life Science and Engineering

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Received Date: 28/01/2015
Accepted Date: 24/02/2015
Published Date: 01/03/2015

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Short Commentary

Bioengineering is the amalgamation of the biology, physics and engineering techniques to solve medical and associated problems. It is advanced stage in engineering field and great revolution in life science. It is also a branch of genetic engineering which helps to make a regenerative medicine.

It is also expanded to molecular level which has tissue as target to expand its study as tissue engineering. Tissue engineering is a used for reconstruction or generation new tissues and/or organs. The limited availability of donor made the need for a second operation site, emphasize the need for alternative approaches such as allografts. As we know that graft rejection is a serious issue for transplantation, it is been exceeded by regeneration of organ by own tissues by the use of scaffold materials that accelerates the regenerative processes which triggered by biological signals [1-5]. It has given good boosting for researchers to develop the technique assessing the healing of broken bones, severe burns, blindness, deafness, heart, blood vessel, nerve and muscle damage and in the treatment of many others diseases. Tissue engineered products consist scaffold and cells will become an alternative to the currently used methods of substitution and regeneration of damaged or removed tissues.

Human cells are multicellular organisms has an inherent ability to replicate under respective regulatory constraints for the requirements of a normal healing process. Stem cells are added points which can be used as proliferation and differentiation processes responsible for repairing and replacing damage tissues, has the capability of self-renewal or the property of growing through the symmetrical or asymmetrical cell division process [6]. Rate of proliferation extremely depends on the number of initial cell populations, rate of cell division, growth factors and their proliferative capability.

The basic step is a supplement of growth process, which made to regulation because of the extended cell survival at this stage the function of tissue and morphogenesis is responsible to create a route in case of genetic instability and growth of mutations [7-15]. Proliferative cell populations converge with the experimental hypothesis.

There are several potential aspects of using cells in repair and reconstruct of tissues. Stem cells based tissue engineering is thought to be a path to replace the missing and regenerate damaged organs [16-19]. Successfully the usage of all types of stem cells in regeneration therapy may achieve only after knowing of the basic concept of molecular mechanisms underlying cell operation in stem cells. It will be an essential contribution to ensure their safe use in regenerate organ.

The initiation of process carried out by placing of stem cell into the scaffold material and implantation of the construct elsewhere in the body. They grow, mature and finally extracted to implanted as per requirement. In another, stem cells are also released from the tissue are implanted into a severely injured to help and regenerate the pulp and that can restore[20].

Allografts have a poor degree of cellularity, reduced vascular supply and a higher resorption rate compared to autologous grafts. Recently mesenchymal stem cells have been used in association with scaffolds and differentiation inducing factors to develop organ[21-27]. General approach to organ-regeneration is to stimulate the exit of reparative cells from their nitche to enter the blood stream and travel, or move by ameboid

action, to a site of injury. Once at the injury site, they then differentiate into the cells needed to repair the tissue. Once at the site, smart biomaterials can be used to further help engraft and differentiate the cells. This approach has been used for tooth and periodontal regeneration musculoskeletal regeneration and cardiovascular disease.

Chitosan has been frequently used as a matrix in association with bone marrow stem cells to generate bone in sites of the body [28-30]. The model engineered to generate bone over existing cortical bone instead. This idea of bone regeneration beyond the skeletal envelope was already achieved using a titanium mesh as a barrier over the existing bone, without the use of any grafting material. Degree of acetylation of 4% can thus provide a non-protein matrix structurally similar to extracellular proteoglycans for 3D cell viability, spreading and growth.

This bone regeneration technique could potentially be applied in the field of oral-maxillofacial surgery, mainly in the repair of alveolar ridge height and width, filling periodontal defects and alveolar clefts in addition to surface contouring of the face like bone augmentation of malar bones, chin and mandibular angle[31]. It is made up of β (1-4)-linked N-acetyl-D-glucosamine and D-glucosamine subunits and is produced industrially by alkaline hydrolysis of chitin.

Tissues are composed biologically not only of cells, but also extracellular matrix which has a dynamic and functional role in providing cell growth factors and producing chemokines that makes cells for regeneration[32]. They also provide in three dimensional spaces for either seeded or native cells to integrate into new tissues. Tissue-specific factors acts as physical support supplied for organ matrix, when bone marrow derived mesenchymal stem cells are used to enrich grafting matrices, it almost invariably produced faster and more consistent defect healing compared with the carrier matrix[33]. Researches have proved that inducer of bone marrow derived from mesenchymal stem cells are dexamethasone and growth factors like BMP-2, and 1, 25-dihydroxyvitamin D.

Biomaterial is natural or synthetic substance that incorporates or integrates into a patient's tissues during the treatment. Compound should be inert, sterile, non-carcinogenic, mechanical durable, should cause no inflammatory or immune reaction, be inexpensive, easy to use and withstand modification by body tissues. The aim of a biomaterial is to perform, supplement or replace a natural function that is attenuated or lost. The degradation rate of scaffolds used for tissue engineering is an important factor for timely maintenance of biomechanical properties, while allowing resorption of the material when a new matrix has developed [34-36].

For this approach to work there is a need to have a keen appreciation of the cell trafficking mechanisms of the cells needed for repair. Cell sources needed for repair may decline with age and disease. A multi-cue approach may be needed to stimulate cells to leave their nitche, travel, migrate, differentiate and engraft in the damaged tissue. Many studies suggested that, regulatory mechanism of stem cell growth cycle can be described by the factors, responsible for this process. However unlike in-vivo, studies for growth process in the laboratory has many challenges to face depending on the genetic instability, variability and cell contamination and lack of permissive and repressive factors responsible for cellular activities. Results from in vitro experiments needed to run in the laboratory for optimizing the clinical understanding. In in vivo, in vitro studies face ethical, financial and resource limitations in time domain. While this approach has exciting possibilities, it also has its limitations.

Computational analysis has claimed a larger credential in advancing various aspects of bioengineering where higher level of simulation studies are being performed to understand several aspects of important scientific facts including cardiovascular modeling[37], brain or neural modeling and other neuroinformatics studies[38],drug target analysis [39-41], molecular informatics of genes and proteins[42-44],renal modeling[45] etc.

Thus, it is evident from the above discussion that bioengineering has emerged as a true interdisciplinary, multifaceted scientific stream which aids in overall betterment of mankind with major emphasize on medical sciences, molecular biology associated with medical and other relevant disciplines and other influencing scientific aspects.

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