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Key Words

Biomaterial, Scaffold, Protein, Keratin, Tissue Engineering

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A REVIEW OF THE 3D DESIGNING OF SCAFFOLDS FOR TISSUE ENGINEERING WITH A FOCUS ON KERATIN PROTEIN

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***Abstract*— In tissue engineering scaffolds take the place of the natural extra cellular matrix (ECM). The natural ECM is the extracellular part of animal tissue that usually provides structural support to the animal cells in addition to performing various other important functions. The design aspect along with the choice of the material for the artificial scaffold is very crucial to cell differentiation, adhesion, proliferation, and the transport of the growth factors or other bio molecular signals. In addition to the material and design of the scaffolds, it is necessary to replicate the normal physiological situation if the scaffold has to function as an implant. The cells have to be located in the porous scaffold to form a three dimensional assembly. The article discusses the important factors to be considered while designing a scaffold for tissue engineering and regenerative medicine.**

***Index Terms*— Biomaterial, Scaffold, Protein, Keratin, Tissue Engineering**

I. INTRODUCTION

Scientists have dreamed of a 'body shop', where a patient goes with a prescription for a lost limb or a failing organ and the limb/organ is grown in the shop using details from the patient like DNA or bone marrow for cell multiplication. This regenerated limb/organ is then grafted onto the patient. The limb/organ shall grow naturally as a part of the patient's body [1]. Tissue engineering has the potential to make this dream come true. This approach has gained importance over a few decades due to the drawbacks in traditional tissue or organ transplant such as insufficient number of donors, traumatic procedures and rejections [2]. The basis for this technology is that cells from the patient's own body are isolated and allowed to proliferate, either in vivo or ex vivo, so as to form extra-cellular matrix, and ultimately new tissue [3].

Tissue engineering is a multidisciplinary field that applies the principles of engineering and life sciences [4]. Materials and fabrication technologies are critically important for tissue engineering in designing temporary, artificial extracellular matrices (scaffolds), which support three-dimensional tissue formation [1]. The cell is the basic structural, functional and biological unit of all known living organisms. Cells are the smallest unit of life that is classified as a living thing and are often called the 'building blocks of life'. The cells of plants, animals, fungi, algae are all eukaryotic cells i.e. they contain a nucleus. The nucleus is the information Centre for a cell. Tissue is an ensemble of similar cells from the same origin that together carry out a specific function. It is a cellular organizational level intermediate between cells and a complete organism. Organs are formed by the functional grouping together of multiple tissues. Tissue engineering is the use of combination of cells, engineering and materials with suitable biochemical and physio-chemical factors to improve or replace biological functions. The term regenerative medicine is often used synonymously with tissue engineering. Tissues are fabricated in laboratories by a combination of ECM, cells and biologically active molecules.

The ECM can serve many functions, such as providing support, segregating tissues from one another, and regulating intercellular communication. The extracellular matrix regulates a cell's dynamic behaviour. In addition, it sequesters a wide range of cellular growth factors and acts as a local depot for them. Formation of the extracellular matrix is essential for processes like growth, wound healing and fibrosis. Fibrosis is the formation of excess fibrous connective tissue in an organ or tissue in a reparative or reactive process. Fibrosis can be used to describe the pathological state of excess deposition of fibrous tissue, as well as the process of connective tissue deposition in healing. Scaffolds are artificial structures that are capable of supporting 3D tissue formation. The cells are implanted or seeded in scaffolds and are critical both ex vivo as well as in vivo. The terms ex- vivo and in vitro are not synonymous. In vivo studies are those that are conducted with living organisms in their normal intact state. Ex vivo studies are conducted on functional organs that have been removed from the intact organism. In vitro studies are conducted using components of an organism that have been isolated from their usual biological surroundings. They are commonly called as test tube experiments. In- vitro means 'in glass' in Latin. To restore function or regenerate tissue, a scaffold is necessary that will act as a temporary matrix for cell proliferation and extracellular matrix deposition, with subsequent ingrowth until the tissues are totally restored or regenerated. Scaffolds have been used for tissue engineering such as bone, cartilage, ligament, skin, vascular tissues, neural