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TISSUE ENGINEERING IN SKIN REGENERATION

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ABSTRACT

Nanotechnology is gaining immense popularity and it is serving the cause as well. One of the main advantages to the medical industry is combining tissue engineering with nanotechnology and optimizing the product in a useful way. The possibility of creating organs and tissues with the help of polymers can help the medical industry in many ways. Nanosensors can be used to make glucose monitoring processes simple yet effective. Other methods can be used to soothe the inflammation of the wound. More specifically, tissue engineering aims at promoting hemostasis that aids the process of wound healing, TNT helps in fastening tissue regeneration and scaffold helps in creating new areas for creation of artificial skin, cartilage, bone and other organs.

Key Words: Nanotechnology, Wound, Polymer, Hemostasis, Regeneration

INTRODUCTION

Tissue engineering is a trending and rapidly evolving field which majorly deals with reincorporation of tissues. It's techniques are very much used in regenerative medicine as well. In simple words, replacing damaged tissues or organs with newly created in-vivo substitutes that carry the same functions. With the combination of biological components and synthetic materials, one can make various substitutes. Biodegradable polymer can be used to make a scaffold which then would act as a substitute. Research has already been made by making artificial limbs, cartilage and bones.

Tissue Transfection (TNT) is a method based on the principle of electroporation. It is a technique that delivers genetic material directly into the skin. In this process, temporary pores are created on the surface of the skin with the help of electrical impulse, which facilitates the movement of substances such as nucleic acid.

The extracellular matrix (ECM) that is covered by cells present in the tissue, has various functions such as release of biological factors and plays an important role in the activation of these factors as well as its storage. Skin regeneration basically means the ability of our body to derive a fresh skin after a wound. In order to have a successful regeneration which is a fast paced one as well, it is essential to imply biomaterials that possess the same properties of ECM. This can be done with the help of factors that regulate the gene expression by creating nano feature scaffolds and nano topographic factors.

Nanofeature Scaffolds

Nanoscaffolding is a method used in the medical industry which helps in regrowing bones and tissues. It can also facilitate the re-growth of organs. The cells that are damaged are provided to grip the scaffold and the process of rebuilding the missing tissues or bones start through minor holes that are present in the scaffold. Eventually, when the tissue grows completely, the scaffold is absorbed in the body and disappears completely.

Nanotopographic Factors

The cell behavior can be affected with the presence of nanotopographic factors of the surface. They may affect the adhesion, migration or even spreading of the cells. Nanotopography is the future of regenerative medicine as it not only affects the behavior, but also provides larger surface area. Large surface area makes it easier for the drugs to interact and bind to the site. Advancement in this area will surely benefit the biomedical department.

After a lesion or a cut, our skin has the ability to regenerate on its own, but it takes a long time. In order to minimize the time, trial and error has been done and various methods have been obtained which will be further discussed in this paper.

METHODS

There are not many known methods to perform this task as the field is quite novel. The kind of materials to be used is still unknown and how much the therapy would cost is yet to be determined. There are ethical issues as well regarding the allowance of foreign polymer based materials inside the body. The known methods are discussed below -

- **Nanoparticles**

Nanoparticles help in the delivery of the drug into the site of the body. Along with drug delivery, they are found to be useful in the treatment of diabetes. They can also be very much useful in treatment of non-healing wounds. The size and shape are small and thus, compatible enough for surface reactions to occur properly. Many of these particles help in hastening of the wound and also mitigate the infection.
EGCG (epigallocatechin gallate) is embedded in gold nanoparticles in the presence of lipoic acid which generates an antioxidant effect and also facilitates the process of angiogenesis. This process helps in the delivery of nutrition and oxygen by forming new blood vessels. Finally, the combined effect decreases the macrophage activity that oozes the wound and prevents from having any sorts of infection.

- **TNT (Tissue Based Nanotransfection)**

Custom fabricated nanochannel arrays are used in this method in order to move the cargo into tissues. A reservoir is created with the help of silicon wafers. There are basically two main components: a cargo, and a device(chip).
At first, the chip device is loaded with DNA and RNA (synthetic). There are small needles that contain channels which are implanted in the chip. An electric field is created, and due to disturbances in the charge produced, the cargo is delivered in the cells. With the help of nanoparticles, RNA molecules get delivered to

specific targeted cells and thus, the efficiency of the treatment is incremented tremendously. The efficacy is around 96% and is quite an effective method for wounds as well. This is the most famous and used method till date.

- **Nanofibres**

The most advantageous thing about nanofibres is it provides a scaffold as well as hemostasis. Hemostasis basically means to stop the bleeding and let the blood remain in the damaged vesicle. Some examples of nanofibers are collagen, fibrin, cellulose and many more.
Nanofibres are produced by a process called electrospinning. It is based on the electric force principle, where due to induction and centrifugal force, threads are created which are then condensed to make fibers.
They have anti-inflammatory effects and help in the ailment of a wound.

CONCLUSION

Nano technology is getting famous very quickly. The introduction of Nano-structure in tissue engineering is of great importance. The action of ECM is mimicked and it is observed that the cell response is also affected. Nanofibres as mentioned above, are the duplicates of naturally occurring ECM that enhances cell differentiation and also helps in the development of new tissues and re-generation of skin on wounds. Sometimes, in order to make a multi-component structure of bone, apatite crystals are added to the scaffold. The scaffold mimics the action of deposition of these crystals in the ECM. Thus, incorporation of these nano-particles into the scaffolds facilitates cell growth, regulates it's behavior and enhances the chances of tissue regeneration. The research in this field is a never ending topic and clinical trials are yet to be held on humans. The advances in technology would surely help the process and nanotechnology would take a different toll in near future.

DISCUSSION

Application of nanotechnology has maneuvered the medicine industry in a very innovative way. An enormous amount of effort is being put in this field for further research. The possibility of having an artificial organ, tissue or bone is unimaginable and success of the ease of getting these treatments done, will open a high number of gateways for further research. The in depth study of organs will become quite easy and will be ready at hand for students, doctors as well as research scientists. The ethical issues regarding human trials will get banished. Creating these organs or tissues with the help of bioactive polymers which are abundant in nature is quite useful for progressing the scope for treatment of various diseases.
Nothing comes easy in any form of research, thus a gap which is found in these methods, is the emergence of tumors. The main focus of these bioactive materials is to make cells activate their functions so that the regeneration procedure starts. Unfortunately, scientists are unaware of the fact that whether these polymers are adaptive to the body structure or not. Everyone possesses a different body type and structure, thus indulgence of these foreign materials may produce a tumor in some people, which will be a very dangerous process.
The recent advances have shown that silicon is a compatible polymer, but is yet to be tested properly.

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