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Restoring, Repairing, and Regenerating Tissues through Biomaterials, Cells, Scaffolds, and Innovative Technologies

Muhammad Akram[1], Isaac John Umaru[2], Abid Mahmood[3], Mohammed Khudhair Hasan[4], Hind A. Abdulghafoor[5], Fahad Said Khan[6], Fethi Ahmet Ozdemir[7], Gaweł Sołowski[8], Jaouher Ben Ali[9]

[1,3]Government College University Faisalabad, Pakistan; [2]Federal University Wukari Taraba State, Nigeria; [4]Al Manara College for Medical Sciences, Maysan, Iraq; [5]University of Fallujah, Iraq; [6]University of Poonch Rawalakot, Azad Jammu and Kashmir, Pakistan; [7,8]Bingol University, Bingol, Türkiye; [9]University of Tunis, Tunisia

makram_0451@yahoo.com

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Abstract

Tissue engineering and regenerative medicine (TERM) is an innovative area of research and development that includes biomaterials, cells, scaffolds, scaffolding structures, and even bioactive substances to restore, repair or regenerate damaged tissues along with organs. The scope of synthetic skin expansion has now progressed to engineering kidneys, hearts, and lungs. Use of stem cell therapies or extracellular matrices for organ healing and regeneration are other; notable shifts toward tissue engineering paradigm are towards healing adn regeneration rather than the development of reconstructive surgery. While research has shown promise, there are still concerns regarding its clinical use citing complications such as immune system rejection of newly implanted tissues, ethical issues and the economical creation of engineered tissues. The efforts being made in Asia demonstrate emerging potential in TERM. Enhanced collaboration across disciplines is essential to pave new ways towards realizing current restrictions and bold influencing ideas alongside breakthroughs.

Keywords: Regenerative Medicine, Tissue Engineering, Bioactive Molecules, Extracellular Matrix, Organ Regeneration

Introduction

Creating functioning tissues by fusing cells, scaffolds, and physiologically active substances is known as tissue engineering. The field of biomaterials development gave rise to it. Although the FDA has previously approved synthetic tissues like skin and cartilage, there are still limitations on how they may be used in human patients. Tissue engineering and the idea of self-healing—in which the body repairs organs or cells using its own processes, sometimes with the help of external biological material—are both part of the broad field of regenerative medicine.

The terms "tissue engineering" and "regenerative medicine" are almost interchangeable as the field seeks to find solutions rather than cures for complex, often chronic diseases.(Katari et al.,2015)Cells are the building blocks of tissue, even though tissues are the organism's basic functional unit. The support structures that cell groups often create and secrete are referred to as extracellular matrix. (Bosman et al.,2003)Cells may be injected with or without a combination of growth agents after the scaffolds are built. If the circumstances are right, a tissue develops. Combining cells, scaffolds, and growth factors can sometimes cause This method has been used to bioengineer tissue in the kidney, liver, heart, and lungs. By fusing the patient's own cells with scaffolds of human tissue that are thrown away after surgery, this technique holds great promise for producing customized organs that the patient's immune system won't reject. Tissue engineering currently has little effect on patient treatment. Nonetheless, research can benefit much from these tissues, particularly in the discovery of new drugs. (Elliott et al.,2011)Investigating novel approaches to enhance healthcare for the elderly and sick population is still a global problem. Tissue engineering and regenerative medicine (TERM) has steadily become one of the most promising approaches to address patients' future demands among the several techniques to accomplish this aim. (Berthiaume et al.,2011)As demonstrated by the notable rise in the number of researchers, publications, clinical trials, and translational products, TERM has recently drawn more attention in Asia. By showcasing some of the most significant developments in the field and outlining the key accomplishments of representative research groups, this study aims to give a concise summary of the evolution of TERM in Asia during the previous ten years. A brief overview is given on the creation of new biomaterials and supporting technologies, the discovery of fresh cell sources, and the uses of TERM in several tissues. Lastly, TERM's accomplishments in Asia will be discussed, including significant papers, noteworthy discoveries, clinical studies, and commercial product examples. We'll also talk about the topic's present constraints and potential future paths.

Regenerative Medicine

By either replacing the injured tissue or encouraging organs. When the body is unable to mend itself, regenerative medicine enables researchers to safely implant tissues and organs that have been grown in the lab. According to current projections, regenerative medicine might help around one in three Americans. The term "regenerative medicine" describes a collection of scientific strategies for therapeutic treatments that could make use of stem cells and cellular therapies (injection of stem cells or progenitor cells) are a few examples. Applications for umbilical cord blood stem cells are being investigated in a number of areas, such as cardiovascular repair to see if the cells can migrate specifically to damaged heart tissue and enhance function and blood flow at the injury site; type 1 diabetes to see if the cells can slow the loss of insulin production in children and enhance general heart health; and uses in the central nervous system to determine whether cells go to the site of brain damage, reducing symptoms associated with movement and mending damaged brain tissue (as in cerebral palsy). As medical science advances in using the body's own cells for therapeutic purposes, cord blood stem cells will probably be a valuable tool. Autologous cord blood stem cells have grown in importance as a focus of regenerative medicine research since they can be put back into the human without being rejected by the body's immune system. (Chen et al.,2010)

Tissue Engineering

Tissue engineering, an interdisciplinary discipline with the potential to transform significant areas of medicine, grew rapidly in the early 1990s as a result of the idea of applying engineering to biological tissue healing. a piece of tissue intended to be used as a vascular transplant. Find out how tissue implants cultivated on three-dimensional scaffolds have been demonstrated to be more successful in repairing atherosclerosis-damaged blood arteries. The therapy options for complicated kidney illnesses have been expanded by the successful engineering and transplantation of renal system substitute tissues, such as the urethra and bladder. The production of functional bioartificial limbs using bioartificial scaffolds and tissues is being studied; in 2015, a rat leg with working muscles and veins was the first such limb to be successfully created. (Liu et al.,2007)

Bioactive Molecules

It is evident from the foregoing that plants have a great deal of potential for producing a wide variety of bioactive compounds. Through enhancing bioavailability and preventing negative effects, some bioactive molecules can increase the impact of a certain class or set of drugs. Therefore, it has been demonstrated that these bioactive chemicals are useful in treating stress-related illnesses and chronic human diseases. One of these conditions is diabetes, which is treated using a variety of natural bioactive compounds. The chemical structure of the bioactive compounds used to treat diabetes has a major impact on their potency and effectiveness.

Through particular receptors for chemical recognition, bioactive chemicals enable host cells to interact with their surrounding milieu and control host cell migration, proliferation, and differentiation. Therefore, by activating neighboring or transplanted host cells, the addition of an appropriate bioactive chemical to a tissue-engineered scaffold might encourage tissue regeneration (Lee et al.,2007)

Extracellular Matrix

The apparent changes brought on by aging are another area where the ECM has been demonstrated to affect wound healing processes. Several studies have demonstrated that the response to damage in fetal tissue differs significantly from that in adult tissue. Age-related alterations in skeletal muscle, as well as the effects of ECM aging on the wound healing process, will be discussed because the importance of the ECM in this area has not yet been well explored. Due to the growing number of senior people and the fact that adults' reparative wound healing concerns continue to pose a substantial burden for doctors, these issues are becoming more and more important. The review's following part will concentrate on the many methods that researchers use to gather data on the extracellular matrix (ECM), both quantitatively and qualitatively. We'll talk about the fundamental ideas behind these approaches as well as their benefits and drawbacks. Their contribution to ECM analysis will also be assessed. Second harmonic generation microscopy (SHGM) and Raman spectroscopy, two other less well-known techniques for ECM investigation, will also be assessed. One of the most important things to take into account in tissue engineering applications is the extracellular matrix. (Bowers et al,2010)

Organ Regeneration

In order to lessen reliance on transplants, regenerative treatments have been developed in response to the loss of organs and tissues brought on by illness or damage. These treatments work by using stem cells' ability to self-renew and specialize into many lineages, which can effectively heal a range of illnesses and injuries. The area of regenerative organ or tissue engineering is always growing in an effort to provide biological replacements for damaged tissues or malfunctioning organs. Bioreactors made of media with a specific chemical composition—that is, challenge of sustaining designed organ viability by progressively preserving target cell viability. Regenerating extracorporeal organs also involves the use of stem cells and engineered extracellular matrices. Clinically, a variety of adult stem cell treatments are easily accessible. The use of several stem cell types and tissue engineering approaches for organ regeneration will be the main topic of this review. Their pluripotency, differentiation, and self-renewal capacity have made them important in Alzheimer's disease. (Fedorovich et al.,2011)

Conclusion

Although there has been significant progress, particularly in the solutions to ethical immunological problems, assuring chronic integration and vascularization, and formation of scalable tissue architectures, there remains a multitude of challenges. Advances in tissue modeling, genetics, biomaterials, and multidisciplinary collaboration will be needed to overcome these challenges.

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