

Chapter 9

History, Challenges, and Opportunities in Tissue Engineering

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ABSTRACT

In the last several decades, the area of tissue engineering has experienced significant growth, bringing to the clinic treatments that were long thought to be the stuff of science fiction. Although the use of tissue engineering concepts in clinics is not particularly common, the field is predicted to have a very bright future as more tissues will be added to the list of “clinically applicable tissue engineered constructs.” Future advancements are likely to make it feasible to combine immune-transparent cells with a commercially available scaffold and cultivate them in a sophisticated bioreactor to provide messages specifically designed for the target region. However, much basic and applied scientific study is still needed before off-the-shelf body parts become therapeutically useful. The development of innovative biomaterials for the various tissue engineering and regenerative medicine applications will be the main focus of future efforts. The biomaterials’ structure and mechanical characteristics will be tailored to better fit the target tissue.

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INTRODUCTION

The multidisciplinary area of tissue engineering makes use of cells, biomaterials, biochemical (such as growth factors), physical (such as mechanical loading), and combinations of these signals to produce tissue-like structures (Berthiaume et al., 2011). Biological replacements that can preserve, repair, or enhance the function of injured tissues are what tissue engineering aims to produce (Langer & Vacanti, 1993). Despite the fact that the first tissue-engineered skin products were first made available in the late 1970s and early 1980s, giving rise to contemporary tissue engineering, the phrase “tissue engineering” was not created until 1987 (Bell et al., 1981; Green et al., 1979; Rheinwald & Green, 1975; Viola et al., 2003).

In truth, the usage of prosthesis dates back to the ancient Egyptians, who used wooden limbs and toes in place of missing limbs and gold for the restoration of missing teeth. The nonliving materials used in all of these therapies, albeit they supplied some structure and function, were a very long way from the original tissue. Around the middle of the 20th century, medical advancements made it possible to replace a whole organ with an organ from a donor, a procedure now known as organ transplantation (Harrison, Merrill, & Murray, 1956). Although this is a common technique today and is recognised as the only effective treatment for organ failure, the demand for organs is always greater than the supply of donated organs (Vacanti & Vacanti, 2007). The notion of *in vitro* generated tissues was motivated by the limited availability of donors and the immune system’s resistance of grafts. The success of skin transplant tissue engineering stimulated curiosity in using related ideas for other tissues and organs (Eberli et al., 2009). Yet, most tissues do not have the skin’s relatively straightforward structure, minimal vascular requirements, or simplicity of *in vitro* keratinocyte growth. The fabrication of intricate, three-dimensional (3D), vascularized multicellular tissues presented significant challenges to the goal of regenerating tissues *in vitro*.

We give a quick overview of tissue engineering in this chapter. Brief discussions are made on the history, foundations, applications, and clinical requirements for tissue engineering. Tissue engineering’s future is briefly reviewed, along with some of the significant obstacles and recent developments in the field.

CLINICAL NEED FOR TISSUE ENGINEERING AND REGENERATIVE MEDICINE

Our desire to heal damaged tissues has led to a clinical demand for tissue engineering and regenerative medicine. Regardless of how these flaws developed (congenital or acquired), conventional medical methods are still unable to effectively or totally correct them. In truth, there are many health issues for which traditional medicine is severely limited in its ability to provide a remedy. Pharmaceuticals are often used to treat illnesses and injuries, while prosthetic devices and organ transplants are utilised to treat more serious disorders. Pharmaceuticals may be helpful in treating a variety of ailments, but they are unable to treat some fatal illnesses (such as various cancers, strokes, diabetes, etc.) or illnesses that are in advanced stages (such as Alzheimer’s, Parkinson’s, osteoarthritis, etc.). Yet, prosthetic devices are unable to restore normal function, and there are always many fewer organ donors than needed. This kind of engineering can be utilised to heal illnesses that are resistant to conventional medicine and to produce real, functional organs, eliminating the need for organ donors and prostheses.

The creation of functional replacements for injured tissues is the primary objective of tissue engineering (Schachter, 2014). According to estimates, the majority of tissue engineering products are used to

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