Tissue Engineering

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The field of tissue engineering has grown from a subfield of biomaterials to a field of its own. It is "an interdisciplinary field that applies the principles of engineering and life sciences towards the development of biological substitutes that aim to maintain, restore, or improve tissue function."[i] Simply put, tissue engineering aims to create cells, tissue, and organs for replacement or insertion into a donor. The earliest account of someone growing cells is Robert Hooke, who in 1907 successfully grew ectodermal cells from a frog. In 1970, orthopedic surgeon W.T. Green began a series of experiments generating cartilage and implanting it into mice. Despite being unsuccessful, Green correctly theorized that cells could be grown on scaffolds and implanted to become functional tissue. From then on the field of tissue engineering grew into a discipline much of its own.

The method of creating tissue from cells is in general quite simple. The process begins with the collection of cells from whichever tissue is being grown. If, for instance, skin were being created then keratinocyte cells would be gathered; Stem cells can also be used for generating many tissues. The cells are preferred to come from the person who will receive the tissue because it cuts down on the possibility of rejection after implantation. After cells are collected they are seeded onto a scaffold. Scaffolds serve as a structural framework for the cells to grow on. It is necessary for the scaffold to be placed in a bioreactor as well. Bioreactors are pieces of equipment that resemble the conditions inside the human body.

There are many different options for both the scaffolds and bioreactors in the tissue generation process. The scaffolds used need to support three dimensional tissue formations as well as be biodegradable. There are many sources such as collagen, alginate and synthetic polymers like polyglycolic acid (PGA) and polylactic acid (PLLA). These are frequently used because they are biodegradable, easily accepted by the body, and their degradation rate can be manipulated. The synthetic polymers are most common because the body metabolically eliminates them as glycolic and lactic acid. There are many techniques for creating the scaffolds. The solvent casting method incorporates placing PLLA in a chloroform solution along with salt particles with a specified diameter. After evaporating the solution, salt particles are left embedded in the structure, which is then submerged in water to dissolve them. This leaves a porous structure and is just one example of how scaffolding is produced.

The bioreactors that mimic the conditions inside the human body also have numerous designs. They need to be able to control elements like pH, temperature, pressure, nutrient supply, and waste removal. This is the place where the scaffolding seeded with cells grows into the 3D tissue that will be implanted into the body. There are in general three categories for bioreactors: perfusion reactors, stirred vessels, and rotating reactors. Perfusion reactors provide a steady flow of media over the scaffold; stirred vessels and rotating reactors are essentially spinner flasks that revolve a media around the scaffolding.

Tissue engineering is an emerging field that has huge potential. Developments will help patients with numerous diseases and afflictions, as well as provide life saving biological components for people in need of donor organs and tissues.

Sources

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