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Biomaterials for Bioengineering of the Cornea

Prabir Kumar

Department of Microbiology, Utkal University, University in Bhubaneswar, Odisha, India

Editorial

Medical engineering has evolved over time as an advantageous combination of healthcare practise, biotechnology, and materials science, with the goal of improving human health. Every day, the cornea, an important portion of the eye responsible for the majority of its optical capacity, suffers from accidents or diseases. Biomaterials and bioprinting have proven to be useful in designing appropriate devices for corneal implantation, avoiding problems and overcoming limits of traditional transplantation and other surgical techniques. Because of their great elasticity and flexibility, changeable optical characteristics, and adjustable microstructure, biopolymers have been used extensively in tissue engineering applications throughout medical history. Natural polymers are well tolerated by the body, provide support for tissue regeneration, and are often inexpensive.

Many common corneal illnesses require corneal transplantation as a surgical treatment. However, because to a worldwide scarcity of corneal tissue from qualified donors, many people are unable to have sight-restoring surgery. Furthermore, corneal transplant rejection is a common cause of failure. Bioengineering corneal tissue has recently gotten a lot of press. A variety of materials are currently being studied in effort to aid corneal regeneration. Tectonic durability, biocompatibility with grown cellular elements, transparency, and maybe biodegradability and clinical compliance are all requirements for the optimal substrate. The anatomy and function of the original cornea are considered in this paper as a prelude to evaluating a variety of biomaterials for corneal regeneration, including critical features for optimal material shape and function. Taken together, the information provided provides insight into the requirements for fabricating synthetic and semisynthetic corneas for in vitro modelling of tissue development and disease, pharmaceutical screening, and in vivo application.

Biomaterials used to create corneal substitutes must mimic the natural cornea's structural and functional needs. In a nutshell, materials used as cell support scaffolds must have the following properties: mechanical toughness, biocompatibility, transparency, acceptable biodegradability, and clinical compliance. Natural and manmade polymers are among the most commonly utilised biomaterials. Synthetic polymers allow for customisation of desired features, whereas natural polymers have high biocompatibility.

Collagen used for corneal bioengineering

The tripeptide arginine-glycine-aspartic acid (RGD), which is recognised by cell surface integrin receptors and is critical for cell adhesion, migration, and proliferation, is the most abundant component of ECM in most tissues. Collagen (particularly collagen type I) is widely used in tissue engineering for a variety of reasons, one of which being its ease of manufacture. Collagen type I is an important component of the tendon, ligament, and dermis, and it is relatively inexpensive to produce.

Chemical, physical, and enzymatic procedures have all been examined for collagen crosslinking in bioengineering. For chemical crosslinking of collagen, aldehydes such as formaldehyde and glutaraldehyde, the carbodiimide family (EDC), isocyanate chemical family (hexamethylene diisocyanate), and genipin are often utilised. Enzymatic crosslinking with transglutaminase can improve the mechanical toughness of collagen without generating hazardous by-products [68]. Physical crosslinking comprises UV or dehydrothermal treatment. However, not all of these techniques are used in corneal bioengineering, and some of them leave harmful residues in the collagen-based biomaterial.

Ocular surface regeneration is the tissue engineering of the eye's outermost layer. The optical and biomechanical properties of the tissue-engineered cornea are critical in this method. Tissue created corneas, for example, must be clear and able to endure intraocular pressure of 10–20 mm Hg. As a result of the rise of tissue engineering, biomaterial selection to build acceptable scaffolds is an ongoing research topic. Full thickness, stromal, epithelial, and endothelial kinds of regeneration are the most common approaches in corneal tissue engineering to treat corneal abnormalities. They all entail the use of a scaffold in conjunction with various cell types.

Ophthalmologists and material scientists around the world have encountered a number of obstacles, ranging from the earliest conceptions such as replacing the opaque cornea to cornea wound healing and regeneration. The fundamental understanding of cornea structure has progressed significantly thanks to advances in imaging methods and histology.

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***Address for Correspondence:** Prabir Kumar, Department of Microbiology, Utkal University, University in Bhubaneswar, Odisha, India, E-mail: prabir.k@gmail.com*

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