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REVIEW ARTICLE

Ocular progenitor cells and current applications in regenerative medicines — Review

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Abstract The recent emerging field of regenerative medicine is to present solutions for chronic diseases which cannot be sufficiently repaired by the body's own mechanisms. Stem cells are undifferentiated biological cells and have the potential to develop into many different cell types in the body during early life and growth. Self renewal and totipotency are the characteristic features of stem cells and it holds a promising result for treating various diseases like diabetic foot ulcer, heart diseases, lung diseases, Autism, Skin diseases, arthritis including eye disease. Failure of complete recovery of eye diseases and complications that follow conventional treatments have shifted search to a new form of regenerative medicine using Stem cells. The ocular progenitor cells are remarkable in stem cell biology and replenishing degenerated cells despite being present in low quantity and quiescence in our body has a high therapeutic value. In this paper we have review the applications on ocular progenitor stem cells in treatment of human eye diseases and address the strategies that have been exploited in an effort to regain visual function in the advance treatment of stem cells without any side effects and also present the significance in advance stem cell research.

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Introduction

Stem cell research is a potential and beneficial area in biology and medicine. These stem cells have the potential to become any type of cell in the body. One of the main characteristics of stem cells is their ability to self-renew or multiply while maintaining the potential to develop into other types of cells. There are different sources of stem cells but all types of stem cells have the same capacity to develop into multiple types of cells such as multipotent, pluripotent, and totipotent (Fig. 1). These cells can become cells of the blood, heart, lung, bones, skin, muscles, brain etc.[1] In the last few years, it has been recognized that the systemic and local stem cell therapy has been used to treat various diseases like diabetes, eye diseases, foot ulcer, cancer, lung diseases, arthritis, Parkinson's diseases, Alzheimer's diseases, Osteoporosis etc., with better results. In 2000, India (31.7 million) topped the world with the highest number of people with diabetes mellitus followed by China (20.8 million) with the United States (17.7 million) in second and third place respectively.[2] The eye diseases are the major problem and incurable diseases in India and developing countries because of the current scenario of leading diabetes.[3] Eye diseases (retinopathy) are a possible complication of diabetes, known as diabetic retinopathy. It generally has no early warning signs and may surface suddenly. Sometimes, the person affected will have blurred vision, which deteriorates and improves during the course of a day.

"*Retinopathy*" is a medical term describing the damage to the tiny blood vessels (capillaries) that nourish the retina. The retina is located at the back of the eye and it captures light and relays the information to the brain. The tiny blood vessels are adversely affected by high blood sugar associated with diabetes. The stem cell-based therapy represents newly emerging potential therapeutic approaches for the treatment for the degenerative eye diseases. The eye is a complex organ (Fig. 2) with highly specialized constituent tissues derived from different primordial cell lineages. The retina, for example, develops from neuroectoderm via the optic vesicle; the corneal epithelium is descended from surface ectoderm, while the iris and collagen-rich stroma of the cornea have a neural crest origin. The potential of ocular cells have been used as therapies for specific diseases because of its relative immunological privilege, surgical accessibility, and its being a self-contained system. In order to harness the potential of stem cell-based therapy to provide and restore sight in blind patients, the safety of the cells needs to be studied in detail. For the successful utilization of stem cells for therapeutic purposes, small molecules can be incorporated with or conjugated to them before transplantation to promote specific differentiation pathways.[4] These cells serve to replace damaged cells and produce cytokines, growth factors, and other trophic molecules.[5] Blindness or loss of visual function can be caused by failure of the light path to reach the retina or failure of the retina to capture and convert light to an electrochemical signal before transmission to the brain via optic nerve.[6] The major causes contributing to blindness include age-related macular degeneration (ARMD), diabetic retinopathy, cataracts, and glaucoma[7–9] which are genetically linked[10] and associated with multiple risk factors including diet,[11] hypertension,[12] pregnancy[13] and smoking.[14]

The eye also has many potential target diseases amenable to stem cell-based treatment, such as corneal limbal stem cell deficiency, glaucoma, age-related macular degeneration (AMD), and retinitis pigmentosa (RP). The corneal epithelium is a unique non-keratinised epithelial cell in an orderly arrangement, which is crucial to the

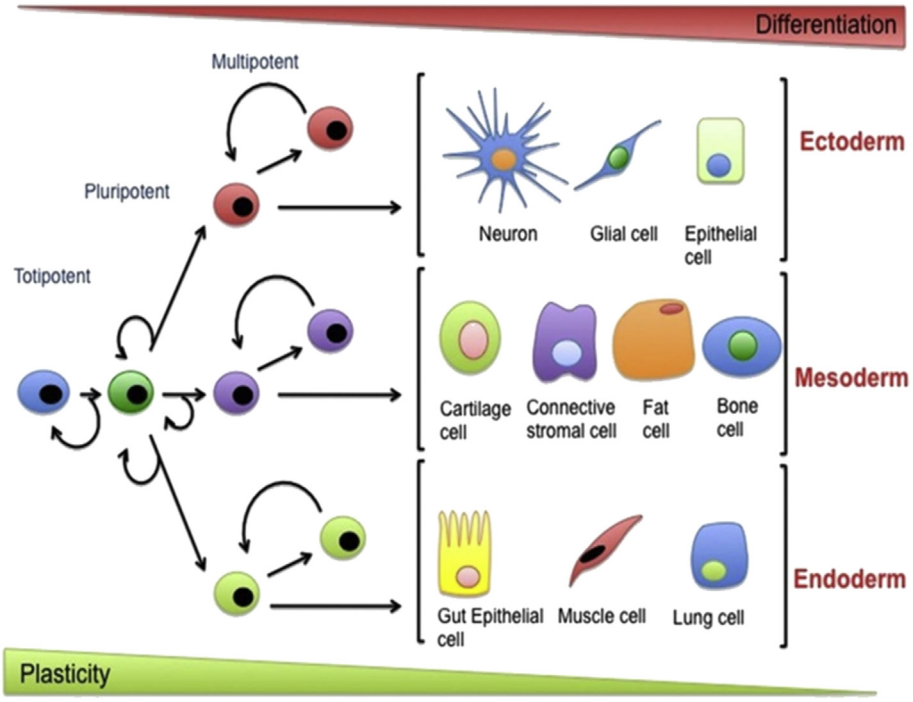

Fig. 1 Hierarchy of stem cells.