## **Retinal Pigment Epithelium Cells and Their Function**

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BIOL293: Cell Biology

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April 15th, 2025

Retinal Pigment Epithelial cells have an indispensable role in human vision and are critical to the maintenance of health and functionality of the retina. Located between the light-sensitive retina and the choroid, a layer of tissue and blood vessels that supply nutrients and oxygen, RPE cells provide support to photoreceptor cells by absorbing excess light, recycling visual pigments, and maintaining the blood-retinal barrier (3). Their unique properties and functions have made them a key target in research for novel therapies for degenerative eye diseases, particularly Age-related Macular Degeneration (AMD), the leading cause of blindness in humans. Understanding the structure, role, and function of RPE cells allows us to better assess their potential in the fields of regenerative medicine and vision restoration.

The Retinal Pigment Epithelium is a monolayer of pigmented hexagonal cells located between the retina and the choroid (1). The RPE cells that make up the monolayer contain melanosomes, a type of specialized organelle that is responsible for the production of the pigment melanin. The melanin within RPE cells protects the retina from excessive light exposure and oxidative stress and helps protect the RPE from damage. RPE cells also perform key tasks, such as the programmed removal of dead or damaged photoreceptor cells in the retina, transporting essential nutrients and ions, and secreting growth factors essential for homeostasis. RPE cells' strategic location, significant role in key homeostatic processes within the eye, and ability to phagocytize non-functional photoreceptors make them an important component of maintaining visual acuity.

Damage to the RPE monolayer is a key factor in the progression of Age-related Macular Degeneration, making it the leading condition targeted by RPE-based

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treatments. Degeneration of the RPE monolayer, caused by various factors but especially by the buildup of common markers for cell death known as Reactive Oxygen Species (ROS), leads to photoreceptor death that causes progressive central vision loss (1). Compromised RPE integrity also compromises the blood-retinal barrier, a protective component within the eye that blocks harmful substances and maintains retinal homeostasis, and is a major factor in the eye's prevention of retinal diseases like AMD. Dysfunction of RPE cells has also been linked with the development of other eye conditions like Stargardt disease and retinitis pigmentosa, both caused by damage to the photoreceptors as a result of failures relating to RPE-controlled processes (2). Scientists are researching promising treatment strategies for preserving and restoring vision in these conditions, involving reinforcement or even replacement of the RPE monolayer.

A particularly exciting development in the field of RPE-cell therapy is the ongoing research into stem cell-derived RPE cells. Scientists are now able to differentiate cells with specializations similar to RPE cells from embryonic stem cells or artificially synthesized induced pluripotent stem cells (iPSCs) (2). This allows for the production of cells suitable for transplantation into the subretinal space, capable of replacing damaged native cells and providing reinforcements for surviving photoreceptors. Clinical studies have shown that these transplanted RPE-like cells are capable of integrating into the host tissue and performing their natural functions, such as phagocytic activity, which allows them to contribute to the regeneration of visual function (2). These transplanted cells treat retinal degenerative diseases such as AMD by restoring the critical functions that are lost due to degeneration of the RPE monolayer. They are fully

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capable of absorbing excess light, phagocytizing damaged photoreceptors, and secreting growth factors for surviving photoreceptors. Like regular RPE cells, they also play a key role in reducing oxidative stress from excess ROS levels and maintaining the blood-retinal barrier, which reinforces the structural integrity of the damaged retina. This restoration of functionality makes stem cell-derived RPE cells a leading option for the treatment of patients with retinal degeneration conditions like AMD and Stargardt's Disease.

Despite these encouraging results, there are still several significant barriers to the efficacy of RPE cell therapy. Researchers face the significant hurdle of ensuring that natural tissue will accept the stem cell-derived RPE cells without triggering immune responses (2). Furthermore, the long-term survival of these transplanted cells is not guaranteed, and producing viable RPE cells of the quality required for survival is extremely challenging to execute with current technology. Current research in the field of RPE cell therapy centers on more effective delivery systems and genomic research for modifications that will promote the creation of cells that won't draw the negative attention of the immune system. These setbacks are all part of the treatment development process, and the potential of RPE cell therapy to decrease or even eradicate the effects of macular degeneration is tantalizing.

Retinal pigment epithelial cells are a foundational element of optical health, and damage to RPE tissue is directly related to multiple forms of progressive blindness. Stem cell research and advancements in medical technology have resulted in the development of viable therapies utilizing RPE cells that could potentially lead to breakthroughs in treatment options for previously incurable degenerative diseases.

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While certain barriers remain before Stem cell-derived RPE therapy becomes medically viable, present results indicate a promising future where degenerative disease-related blindness could go from an irreversible condition to a curable one.

## References

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https://doi.org/10.1016/j.preteyeres.2020.100846