***Short communication***

**ILLUMINATING THE FUTURE: *DANIO RERIO* AS GAME CHANGING MODEL FOR VISION RESTORATION**

**ABSTRACT**

The Danio-rerio model has emerged as a revolutionary tool in biomedical research, offering genetic similarity to humans, cost-effectiveness, and rapid reproduction rates. With 70% of the human genes being similar to danio-rerio, this model has become instrumental in studying genetic disorders, drug discovery, and disease modelling. This article discusses the advantages of this model compared to laboratory animals. This study primarily focused on vision restoration using this model. Blindness remains one of the most challenging medical conditions, with a limited regenerative capacity in the human retina. However, danio-rerio possesses the unique ability to regenerate damaged retinal cells through the activation of Muller glial cells, offering a promising avenue for vision restoration in humans. This remarkable regenerative mechanism has fuelled cutting-edge research aimed at developing novel therapies for retinal diseases such as macular degeneration and retinitis pigmentosa. This study explores the regenerative potential of danio-rerio in curing blindness, highlighting the molecular pathways that drive retinal repair. Additionally, this study explores how these insights are translated into ground-breaking gene and stem cell therapies for human eye diseases. By harnessing the regenerative power of danio-rerio, we can move closer to a future where blindness may no longer be irreversible.

**KEYWORDS:** *Danio rerio*, Retinal regeneration, Muller glial cells, Vision restoration, Blindness cure, Regenerative medicine, Regenerative potential.

**INTRODUCTION**

Blindness is the inability to see or have limited vision that cannot be corrected by a contact lens (Engeszer R.E, et al., 2007). Severity, correction, visual acuity, legal blindness, and the visual field are some of the key concepts of blindness (Streisinger G, et al., 1981). Now a days world-wide despite of age everyone are facing the vision loss problems (Tonon F.,et al., 2020) , this problem is due to various reasons but the ultimate goal is the restoration of the vision (Chen X, et al., 2021). However, this vision restoration is irreversible in humans due to the inactivation of Muller glial cells in human eyes.



 **Figure 1: *Danio rerio* Fish**

*Danio rerio* is a freshwater fish that is mainly native to South Asia (Hason M, et al., 2019). They share significant genetic similarity with humans, making them valuable for studying human diseases (Lenis-Rojas O.A., et al., 2022). The major thing to elaborate on this *danio rerio* is that it has 70% (Wang X, et al., 2022) genetic similarity with humans, as well as transparent embryos that allow real-time observation of organ development (White R.M, et al., 2008). This has become a preferred model in research because of its unique biological and genetic characteristics (Lam S.H, et al., 2004). *danio rerio* also works in the same way as laboratory animals, but its abundant applications and uses are known to have a very small population (Barriuso J,et al., 2015).

Danio rerio is a species of freshwater ray-finned fish belonging to the family *danio nidae* of the order Cypriniforms (Dekens M.P, et al., 2003) Native to south Asia. It is a popular aquarium fish, frequently sold under the trade name danio(Tonon F, et al., 2022) and is thus often called a tropical fish, although it is both tropical and subtropical (Tonon F.,et al., 2016).

**SCIENTIFIC CLASSIFICATION**

Domain - Eukaryota (Li L, et al., 2012)

Kingdom - Animalia (Voisard P., et al., 2022)

Phylum - chordata (van den Boom J, et al., 2018)

Class - Actinopterygii

Order - Cypriniformes

Family – *Danio nidae*

Genus - Danio

Species – *Danio rerio*

This small fish is an important and widely used vertebrate model organism in scientific research (Diogo P., et al., 2023) particularly in developing biology, but also in gene function, oncology, teratology, and drug development (Dougnon G., etal., 2022) in particular preclinical development. It is also notable for its regenerative abilities, and has been modified by researchers to produce many transgenic strains (Rosa J.G.S., et al., 2022).

Some of the advantages of this *danio rerio* model include genetic similarity (Ghaddar B, et al., 2022) rapid development of the embryos, high reproduction rate, transparent embryos, low maintenance cost, and ethical benefits, and it is suitable for molecular and genetic analysis (Russo C.,et al., 2023). As this fish egg develops outside the mother’s body, it is an ideal model for studying organisms during early development (Hamilton F, et al., 1822). The life cycle of *denio rerio* mainly involves the cleavage stage, sphere stage, gastrulation and epiboly, organogenesis, hatching, and adult forms (Spence R., et al., 2008). This model is able to regenerate retinal cells because Muller glial cells are present, contain a greater number of cones, and have excellent color vision (Kimmel C.B , et al., 1995). The steps involved in retinal regeneration in the *danio rerio* model include injury, Müller glial programming, cell division, migration, and differentiation (Howe K., et al., 2013).

Human retinal cells lack this vision restoration due to the absence of Muller glial reprograming or inactivation of Muller glial cells in the eye (Lieschke G.J, et al., 2007). Therefore, understanding a similar mechanism in *danio rerio* to activate Muller glial cells helps to restore vision in humans (Westerfield M, et al., 2014).

**APPLICATIONS**

*Danio rerio* is extensively used in biomedical research because of its unique advantages such as rapid development, transparency, and genetic similarity to humans (White R.M., et al., 2015).

1. ***DISEASE MODELING:*** Human disease research–*danio rerio* is used to model human diseases by reproducing genetic mutations in this fish, observing their development, and testing potential therapies (Bai Q.,et al., 2011). This allows researchers to study the pathogenesis of various diseases including cancer, cardiovascular diseases, and neurological diseases.
2. ***DRUG DISCOVERY AND TXICOLOGY:*** These are used in preclinical research to identify potential drugs and to assess their toxicity (Bandmann O., et al., 2010). These fish larvae have been used to detect retinal toxicity of pharmaceutical compounds.
3. ***DEVELOPMENTAL BIOLOGY:*** These are used for studying developmental processes such as organogenesis and tissue regeneration.
4. ***STUDYING REGENERATIVE MEDICINES:*** They are known for their remarkable regenerative capabilities, making them ideal for studying regeneration and developing strategies for repairing damaged tissues in humans (Das S.,et al., 2014).
5. ***GENETIC AND MOLECULAR STUDIES:*** These fishes were used to identify the function of a gene involved in various biological processes (Laird A.S., et al., 2016).
6. ***TOXICOLOGICAL STUDIES:*** These are used in ecotoxicity testing to assess the impact of substances on aquatic organisms and their environment. They have also been used to investigate the effects of nanoparticles on biological systems (Boehmler W., et al., 2004).
7. ***FLUORESCENT IMAGING:*** *Danio rerio* is used as a fluorescent imaging technique to understand biological processes *in vivo* (Norton W.H.J, et al., 2008).

**CONCLUSION**

*Danio rerio* is one of the best models for understanding the live mechanisms that are likely to occur in our bodies. This transparent embryo helps to study the live growth of these tiny fishes. This model is used not only for vision restoration and several other diseases to study live mechanisms, discover newer drugs, minimize the usage of laboratory animals, and reduce workload and cost, but is also a unique model for performing various research activities, drug discovery, and other studies related to humans.

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