

Zebrafish as a Versatile Vertebrate Model for Cancer, Rare Disease, and Toxicology Research

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The zebrafish (*Danio rerio*) has emerged as a powerful vertebrate model for biomedical research due to its genetic similarity to humans, optical transparency during early development, rapid life cycle, and suitability for high-throughput studies. In recent years, zebrafish has been widely adopted to investigate the molecular basis of cancer, rare diseases, and toxicological responses. In cancer research, transgenic and xenograft zebrafish models enable real-time visualization of tumor initiation, progression, angiogenesis, and metastasis.

In the context of rare diseases, zebrafish provides a versatile platform for functional genomics and disease modelling. Techniques such as CRISPR/Cas9 gene editing allow the rapid generation of mutant lines that mimic human genetic disorders, facilitating the identification of pathogenic mechanisms and potential therapeutic drug targets. Because many human disease genes have zebrafish orthologs, the model is particularly valuable for studying rare developmental and genetic disorders that are difficult to investigate in traditional mammalian models.

Zebrafish is also extensively used in toxicology and environmental health research. Embryonic and larval stages are highly sensitive to chemical exposures, making them suitable for assessing the toxicity, teratogenicity, and pharmacological effects of environmental pollutants, pharmaceuticals, and industrial compounds. High-throughput screening platforms using zebrafish enable rapid evaluation of compound safety, biological impact and potential environmental risk.