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Introduction

Toxicology is the study of harmful effects of substances on living organisms, and it plays a crucial role in ensuring the safety of chemicals [1], pharmaceuticals, and environmental agents. Traditionally, toxicology has relied on animal models to assess the safety and toxicity of various substances. However, in vitro toxicology, which involves the use of cell and tissue cultures outside the organism, has gained prominence as an alternative to animal testing due to its ethical, scientific, and economic advantages. In vitro toxicology allows for the investigation of toxic mechanisms at the cellular and molecular levels, and it is widely used in screening chemicals, evaluating drug safety, and assessing environmental pollutants [2].

In vitro methods in toxicology have become essential tools for understanding the effects of substances on human health, and they serve as valuable complements to traditional animal-based testing. Over the years, the field of in vitro toxicology has seen rapid advancements, with the development of more sophisticated models and high-throughput systems that enable faster and more accurate toxicity assessments [3].

