Pharmacokinetics; Pharmacodynamics; Toxicology; Drug safety; E cacy; Adverse e ects; erapeutic agents; Case studies

Pharmacokinetics (PK) and pharmacodynamics (PD) are fundamental concepts in pharmacology that provide insights into how drugs interact with the body and produce their e ects. In toxicology, these principles are pivotal for assessing drug safety and e cacy. Pharmacokinetics describes the journey of a drug through the body, including its absorption, distribution, metabolism, and excretion. Conversely, pharmacodynamics focuses on the drug's e ects on the body, including its mechanism of action and the relationship between drug concentration and e ect. Bridging these two disciplines allows for a comprehensive understanding of how drugs can be both therapeutic and toxic [1].

Absorption is the process by which a drug enters the bloodstream from its site of administration. Factors in uencing absorption include the drug's chemical properties, formulation, and the route of administration. Bioavailability refers to the proportion of the drug that reaches systemic circulation in an active form. In toxicology, understanding absorption and bioavailability helps predict the potential for systemic toxicity [2].

Once absorbed, drugs are distributed throughout the body. Distribution is in uenced by factors such as blood ow, tissue permeability, and protein binding. e volume of distribution (Vd) indicates the extent to which a drug disperses into body tissues. Toxic substances with high Vd may accumulate in tissues, leading to prolonged exposure and increased risk of toxicity [3].

Metabolism transforms drugs into more water-soluble metabolites for excretion. e liver is the primary site of metabolism, involving enzymatic reactions such as oxidation, reduction, and conjugation. Phase I reactions o en produce reactive metabolites that can contribute to toxicity. Phase II reactions generally render these metabolites more excretable. Understanding metabolism is crucial for identifying potential toxic metabolites and assessing the risk of drug interactions [4].

Excretion is the process by which drugs and their metabolites are eliminated from the body, primarily through the

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these metabolites interact with cellular targets (PD) can help identify potential risks. Case studies of drugs like acetaminophen highlight the importance of this integration in predicting liver toxicity [8].