

Pharmacokinetics and Pharmacodynamics

Pharmacokinetics & Pharmacodynamics – Study Guide

1. Overview

Aspect	Definition	Primary Question
Pharmacokinetics (PK)	What the body does to a drug.	How is the drug absorbed, distributed, metabolized, and eliminated?
Pharmacodynamics (PD)	What the drug does to the body.	How does the drug produce its therapeutic (and toxic) effects?

Both fields are essential for dose selection, predicting drug interactions, and optimizing therapy.

2. Pharmacokinetics (ADME)

2.1 Absorption

- **Goal:** Transfer of drug from site of administration into systemic circulation.
- **Key Factors**
 - **Physicochemical:** Lipophilicity, ionization (pKa), molecular size, polarity.
 - **Formulation:** Salt form, particle size, excipients, controlled?release systems.
 - **Physiological:** Gastric pH, gastric emptying time, intestinal surface area, perfusion, presence of food or other drugs.
- **Common Routes & Characteristics**

Route	Onset	Bioavailability (F)	Advantages	Limitations
Oral (PO)	30?min – 2?h	0.1–1 (first?pass effect)	Convenient, non?invasive	Variable F, GI irritation
Intravenous (IV)	Immediate	1.0	Precise control, 100?% F	Invasive, requires venous access
Intramuscular (IM)	5–30?min	0.5–1	Faster than PO, depot forms	Pain, variable absorption
Subcutaneous (SC)	10–30?min	0.5–1	Simple, can use pumps	Limited volume, variable perfusion

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Route	Onset	Bioavailability (F)	Advantages	Limitations
Inhalation	Seconds–minutes	0.1–0.9	Direct lung effect, rapid	Technique dependent
Transdermal	Hours	0.5–0.9	Steady plasma levels	Skin irritation, limited drug types

2.2 Distribution

- **Concept:** Movement of drug from plasma to tissues.
- **Determinants**
 - **Plasma protein binding** (albumin, α_1 -acid glycoprotein).
 - **Tissue binding** (lipid affinity, melanin binding).
 - **Blood flow** to organs.
 - **Capillary permeability** (fenestrated vs. continuous).
- **Key Parameters**
 - **Volume of Distribution (Vd)** = (Amount of drug in body) / (Plasma concentration).
 - Low Vd ($<0.1 \text{ L/kg}$) ? confined to plasma.
 - High Vd ($>0.7 \text{ L/kg}$) ? extensive tissue sequestration.
 - **Fraction unbound (fu)** ? pharmacologically active portion.

2.3 Metabolism (Biotransformation)

- **Purpose:** Convert lipophilic parent drug into more water-soluble metabolites for excretion.
- **Phases**

Phase	Main Enzymes	Typical Reactions
Phase I	Cytochrome P450 (CYP) isoforms, FMOs, esterases	Oxidation, reduction, hydrolysis
Phase II	Transferases (UGTs, SULTs, GSTs, NATs)	Conjugation (glucuronidation, sulfation, glutathione)