
 REVIEW
ARTICLE

Spectroscopic and Thermodynamic Aspects of Interactions of Serum Albumins with Antibiotics: A Review

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Abstract—The most prevalent protein in the bloodstream, serum albumins—mainly human serum albumin (HSA) and bovine serum albumin (BSA)—are essential to the pharmacokinetics of numerous medications, including antibiotics. HSA is a crucial modulator of drug transport, distribution, and efficacy due to its broad range of endogenous and exogenous chemical binding capabilities. Antibiotic interactions with serum albumins are particularly significant as they directly influence the bioavailability of the free, pharmacologically active form of the drug. High binding affinity to albumin often results in prolonged half-life but reduced therapeutic action due to limited free drug concentration, whereas low binding may lead to increased clearance and potential toxicity. Understanding these interactions is essential for precise dose adjustment, especially in clinical scenarios involving altered albumin levels such as liver dysfunction, renal disease, inflammation, or critical illness. Various spectroscopic techniques—such as fluorescence quenching, circular dichroism, and UV-visible absorption spectroscopy—alongside molecular docking and simulation studies have been instrumental in characterizing the binding mechanisms, sites, and conformational changes induced in albumin upon interaction with antibiotics. Moreover, differences in binding affinity based on the class of antibiotic (e.g., β -lactams, aminoglycosides, fluoroquinolones, lincosamide) and structural properties further complicate dosing regimens. Advances in computational chemistry and personalized medicine offer promising tools to predict and optimize these interactions for individual patients. This review emphasizes the biochemical, biophysical, and clinical relevance of serum albumin–antibiotic interactions and highlights the need for continued interdisciplinary research to refine pharmacological models and improve therapeutic outcomes.

Keyword: antibiotics, drugs, BSA, HSA, interactions, fluorescence, UV-visible

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1. INTRODUCTION

The blood protein known as serum albumin is essential for the movement and distribution of numerous medications throughout the body. Drugs can bind to albumin when they enter the bloodstream, which can have a variety of pharmacokinetic and pharmacodynamic effects. These are some significant drug–serum albumin interactions [1–5].

Drug binding: Many drugs, particularly small-molecule drugs, can bind reversibly to albumin. This binding affects the drug's concentration in the bloodstream, which can impact its distribution to target tissues. Drugs that are highly bound to albumin have a smaller fraction available for therapeutic action [5–8].

Altered drug pharmacokinetics: Drug–albumin binding can influence the pharmacokinetics of a drug. When a drug binds to albumin, it has a larger volume of distribution, which means it is distributed more in the blood and less in tissues. This can impact drug clearance, distribution, and elimination [8–10].

Prolonged drug action: Binding to albumin can protect a drug from rapid metabolism or excretion, leading to a longer duration of action in the body. This can be an advantage for some drugs, such as those used in chronic conditions [10, 11].

Competition with other drugs: Since albumin has limited binding sites, multiple drugs that are highly protein-bound can compete for binding to albumin. This competition can lead to displacement of one drug by another, potentially altering their free (active) concentrations in the bloodstream [11–14].