Multifunctional amphicharged and bolaamphiphilic surfactants derived from amino acids: The effect of pH and temperature on their interactions with bovine serum albumin (BSA) and lysozyme (LYZ)

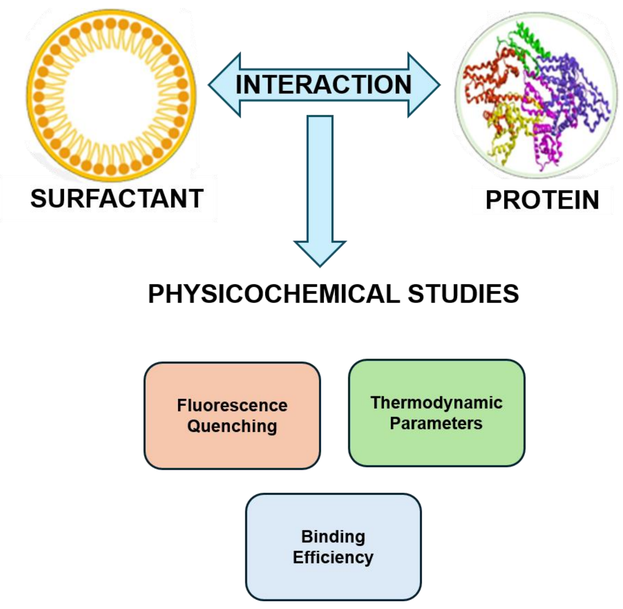
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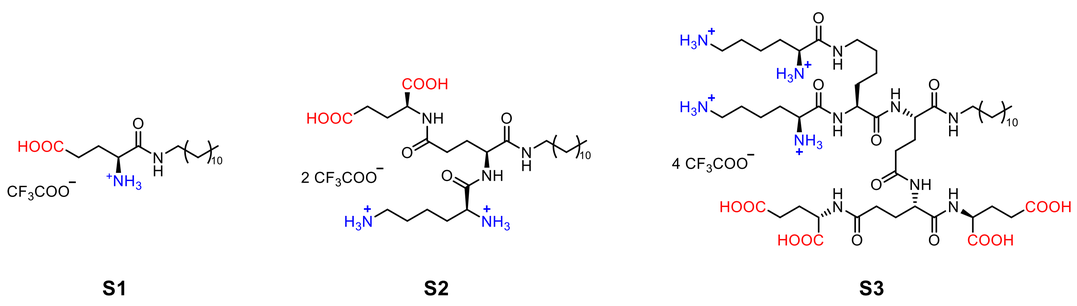
Introduction

- Surfactants, on binding with proteins, are known to exhibit certain structural and functional modifications in the protein structure which can be exploited for their applications in cosmetics and pharmaceutical industries.
- Traditionally, amino acid-based surfactants containing only one functionality in the head group have been studied.
- To explore the applications of surfactants derived from amino acids and peptides, we have designed amphicharged and bolaamphiphilic surfactants for the first time.
- These surfactants exist in different ionic forms at different environmental conditions. We have studied their varied interactions with BSA and LYZ at different pH and temperatures.



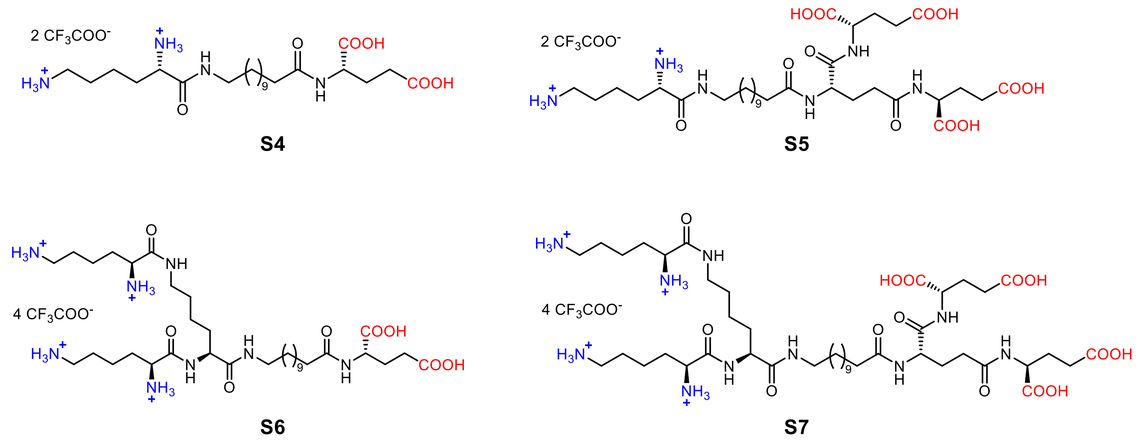
Structure of the surfactants

Structure of amphicharged surfactants

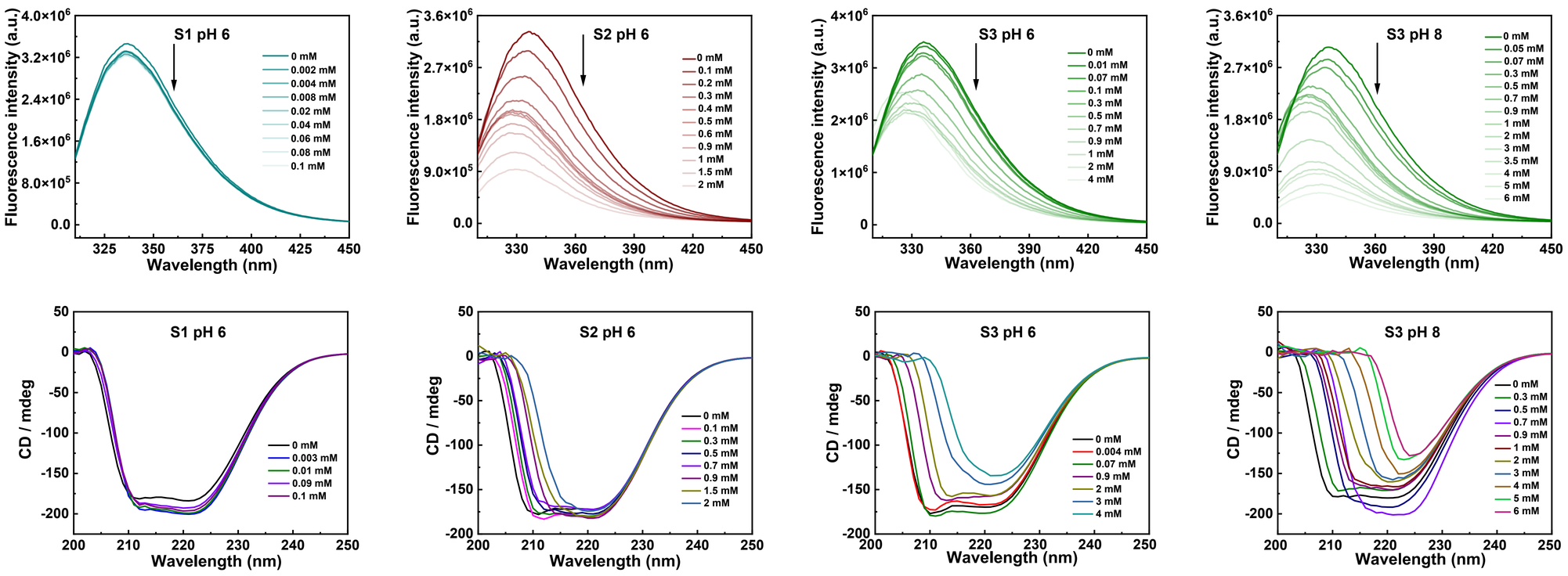


Surfactants **S1-S7** were synthesized using conventional solution phase peptide coupling strategy employing carbodiimide-mediated activation of the carboxylic acid (EDC·HCl) in the presence of HOBt and DIPEA.

Structure of bolaamphiphilic surfactants



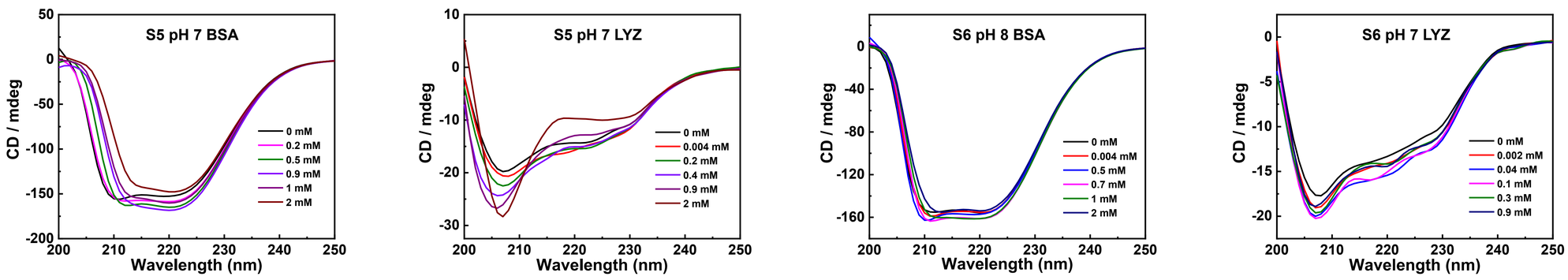
Studies showing quenching of fluorescence intensity of BSA and conformational changes in its secondary structure in the presence of amphicharged surfactants (S1-S3)



S2 exhibits maximum BSA binding affinity at pH 6, whereas **S3** shows increasing binding affinity with increasing pH from 6 to 8

S2 and **S3** stabilize the α-helical structure of BSA at low concentrations, which transitions to a β-sheet-rich conformation at higher concentrations

Circular Dichroism studies showing conformational changes in the secondary structure of BSA and LYZ in the presence of bolaamphiphilic surfactants S5 and S6 at different pH



The surfactants destabilize the secondary structure of BSA but enhance the % α-helicity of LYZ

Summary

- Temperature- and pH-dependent surfactant-protein interactions with BSA and LYZ were studied spectroscopically. Amphicharged surfactants bind strongly under optimized conditions, whereas bolaamphiphilic surfactants maintain efficient interactions across broader conditions.

Acknowledgement

- Department of Chemistry, IIT Kanpur

References

- Gupta *et al.*, *J. Surfact. Deterg.* **2025**, *28*, 501.
- Gupta *et al.*, *Langmuir* **2026**, *42*, 12108.