Stimuli-responsive polydopamine nanoparticle disassembly for drug delivery applications

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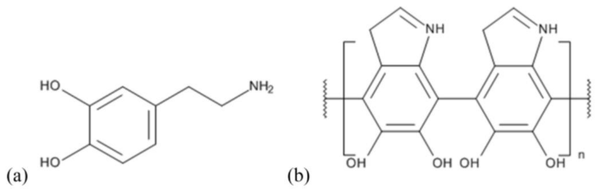
Introduction

- Polydopamine (PDA) has attracted significant research attention in biomedical fields due to its simple synthesis and multifunctional properties.[1]
- Its chemical structure allows for strong adhesion,[2] enabling drug loading.[3]
- Polydopamine's inherent biocompatibility[1] combined with its drug retention abilities[3] make it ideal for applications in drug delivery systems.

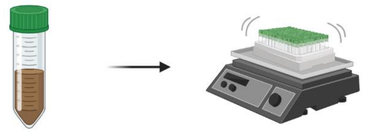


Chemical structures of (a) dopamine and (b) polydopamine[4]

This project explores the disassembly of polydopamine nanoparticles using amino acids that can facilitate the on-demand release of drugs

Methods

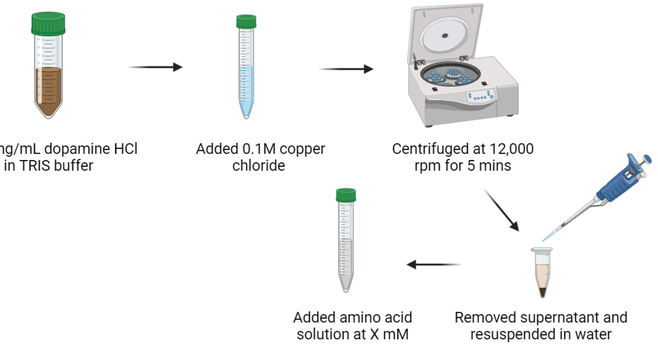
Preparation of Polydopamine Oligomers



0.20 mg/mL dopamine HCl in TRIS buffer

60 rpm shaker for 24 hours

Assembly and Disassembly of Polydopamine Nanoparticles



0.20 mg/mL dopamine HCl in TRIS buffer

Added 0.1M copper chloride

Centrifuged at 12,000 rpm for 5 mins

Removed supernatant and resuspended in water

Added amino acid solution at X mM

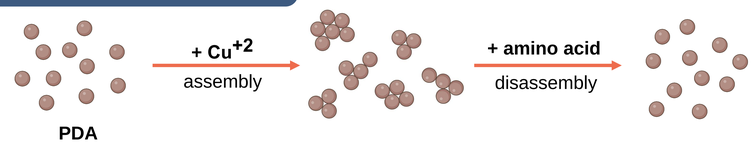
Instruments

DLS measures the random particle movements to determine its size[5]

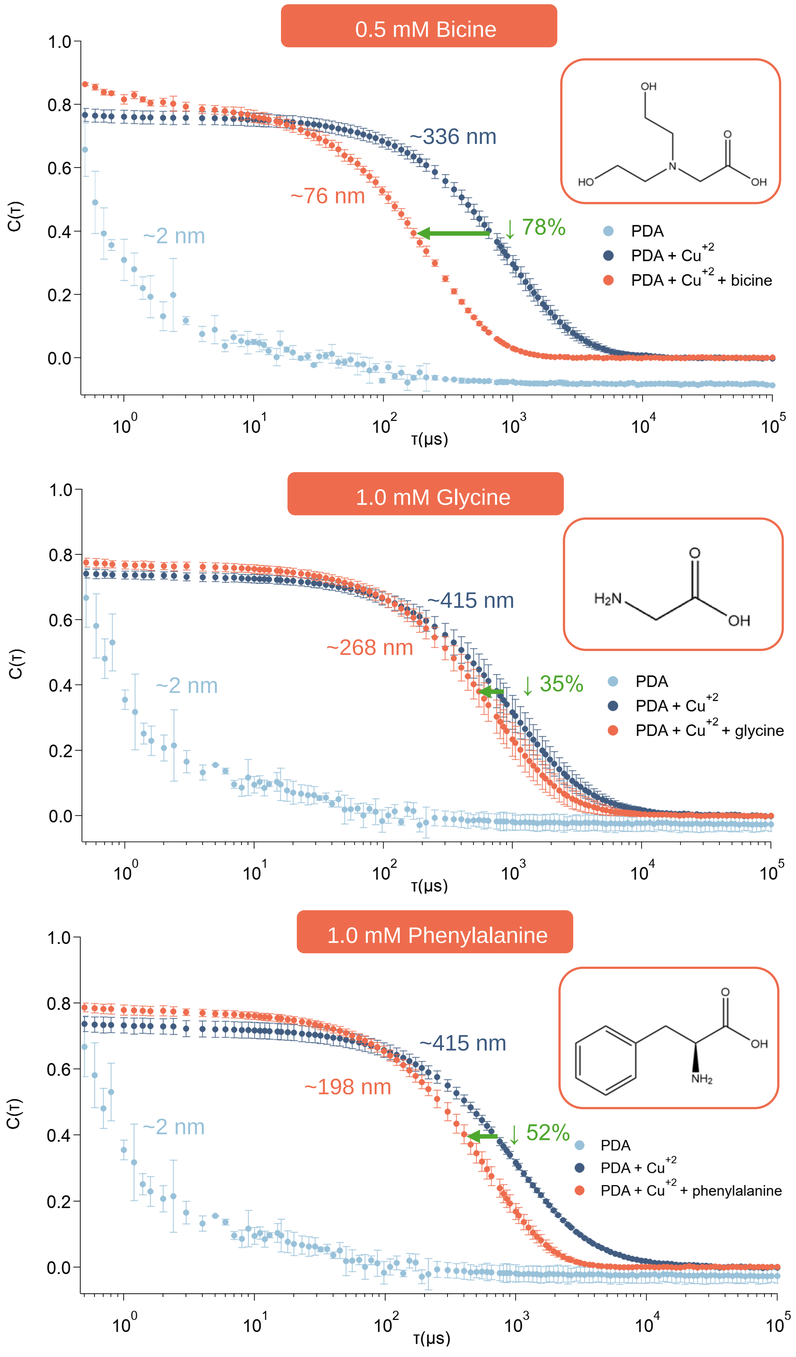
UV-vis measures the light absorbed at a wavelength range[6]

TEM uses transmitted electrons to image and size particles[7]

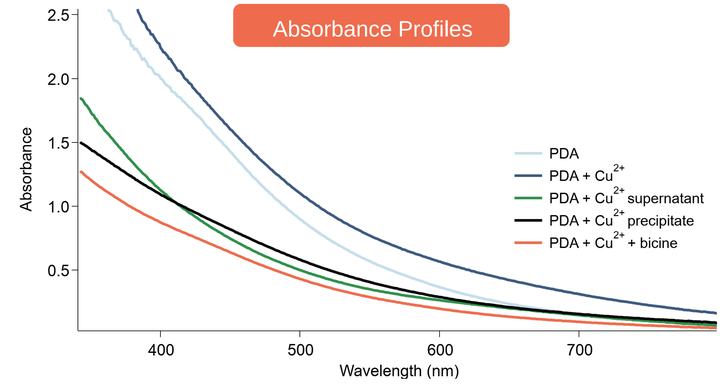
Schematic



Results



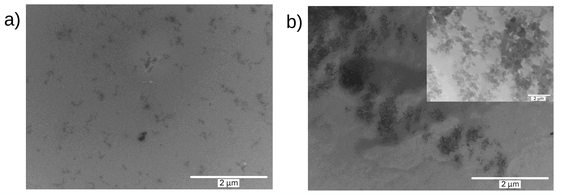
Results



TEM Images

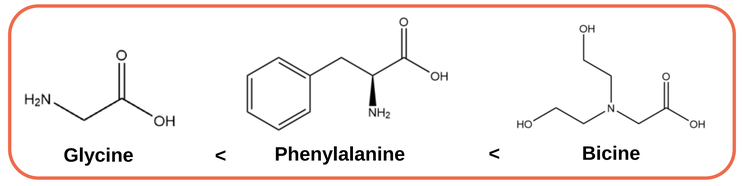
a) PDA

b) PDA + Cu^{+2}



Conclusion

Relative polydopamine disassembly strength of amino acids



Glycine	Phenylalanine	Bicine
• Hydrophilic	• Hydrophobic	• Hydrophillic
• Zwitterionic*	• Zwitterionic*	• Zwitterionic*
		• Glycine derivative

*Has a net 0 charge at neutral pH

Future Directions

- This project investigates using amino acids to disassemble nanoparticles formed from polydopamine and the divalent metal cation, Cu^{+2} – facilitating on-demand drug release.
- Further investigation will examine the disassembly process using amino acids with varying physical characteristics, such as those with acidic and basic side chains.

References

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