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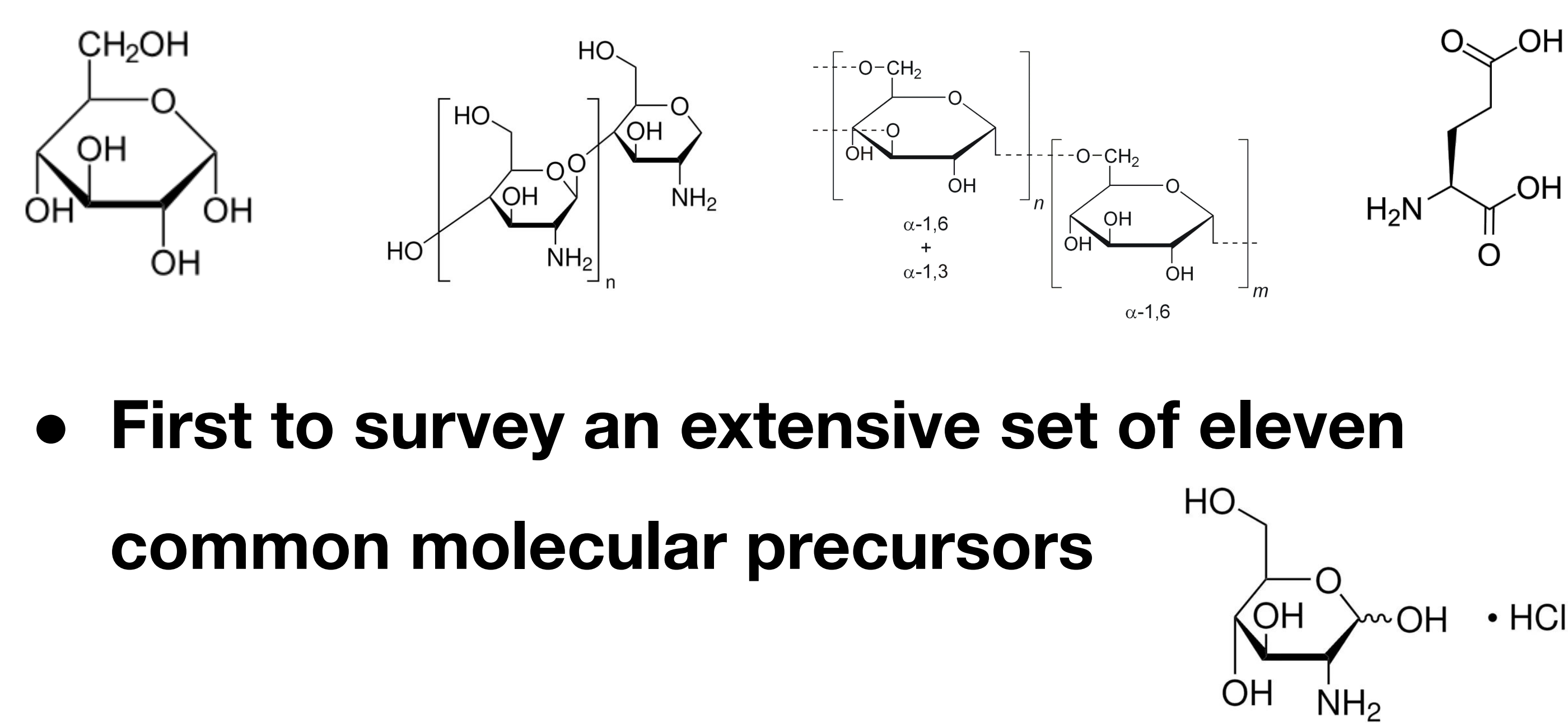
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Abstract

Graphene quantum dots (GQDs) have emerged as important bioimaging tools because of their biocompatibility and the ability of some to perform deep-penetration near-infrared (NIR) fluorescence imaging. The development of NIR-fluorescent GQDs from various precursors can enhance their use in multiplex imaging, multi-analyte sensing, and combination therapy delivery. Herein, we present the synthesis of an unprecedented set of 11 distinct GQD structures capable of NIR fluorescence, achieved through microwave-assisted bottom-up carbonization of 11 precursors: ascorbic acid, chitosan, citric acid-urea, dextran, glucose, glucosamine hydrochloride, hyaluronic acid, L-glutamic acid, polyethylene glycol, sodium cholate, or sodium citrate. All GQDs exhibit biocompatibility at up to 2.20 mg/mL and can be tracked *in vitro* by their NIR fluorescence, while demonstrating effective internalization in HEK-293 cells. This work provides a unique, comprehensive study, offering versatility in synthesis and physical/chemical properties of biocompatible NIR-emitting GQDs suited for a range of bioimaging applications.

Introduction

- Water soluble
- Nano-sized
- Drug delivery
- Cell imaging
- Gene targeting

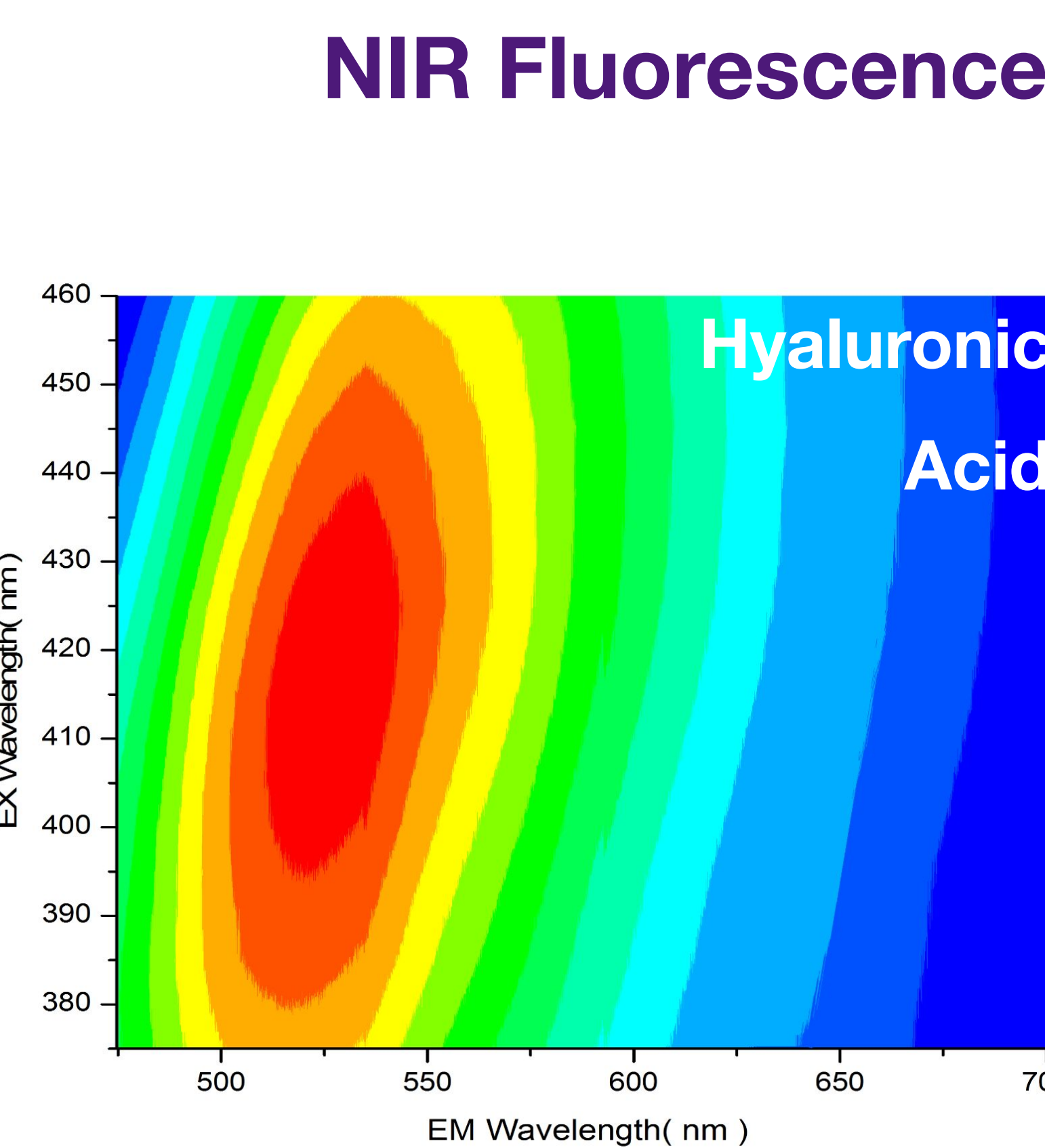
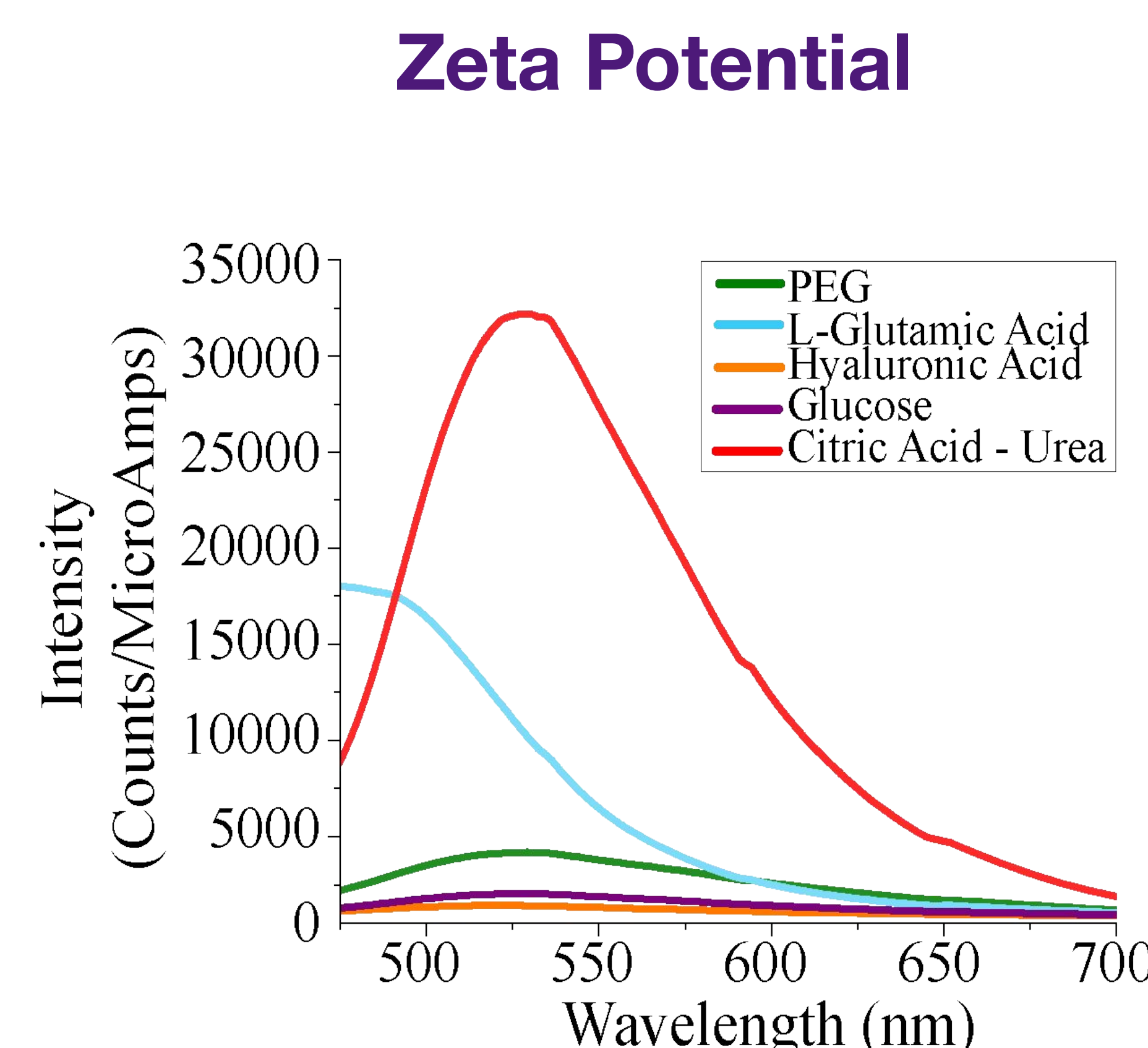
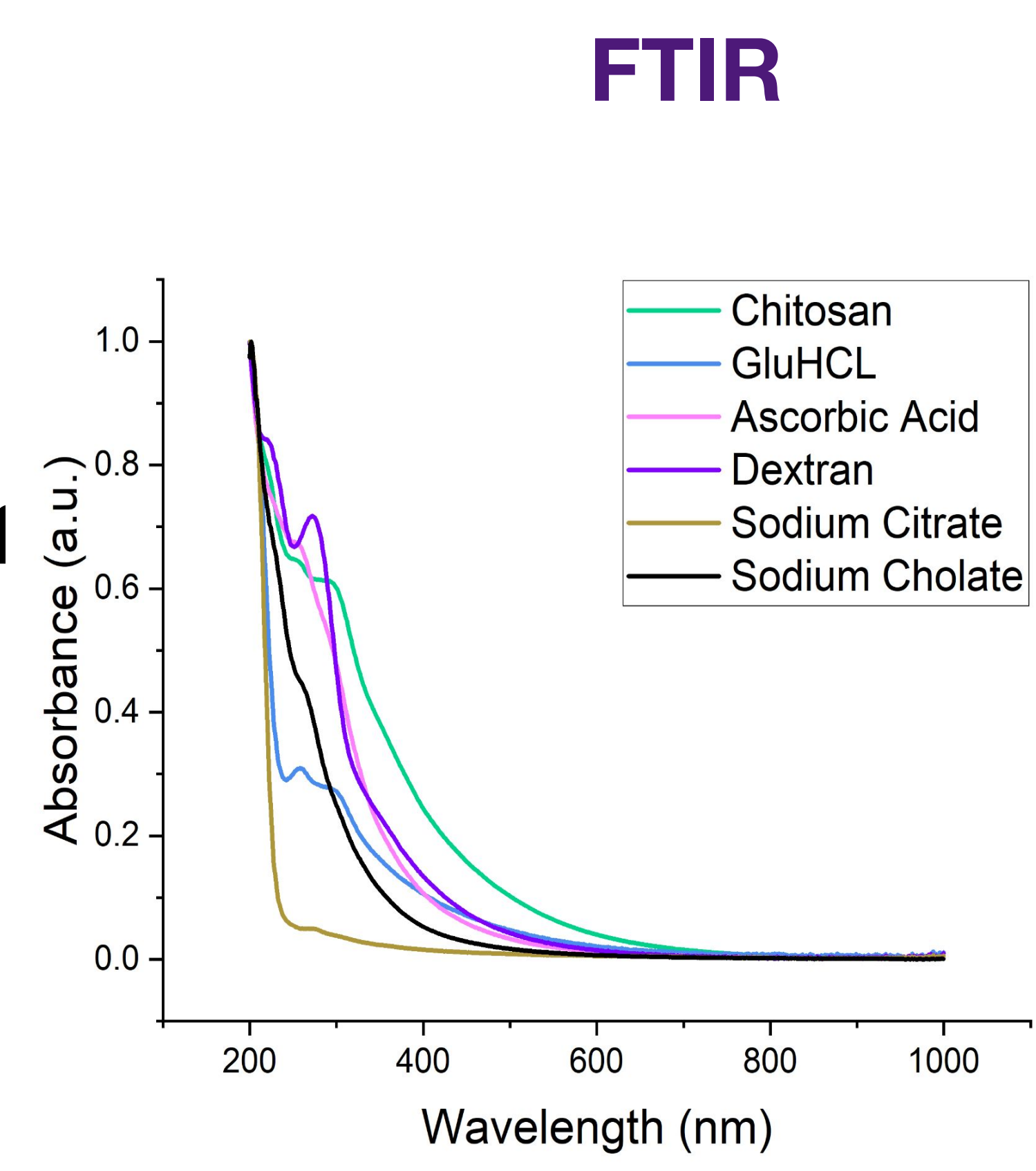
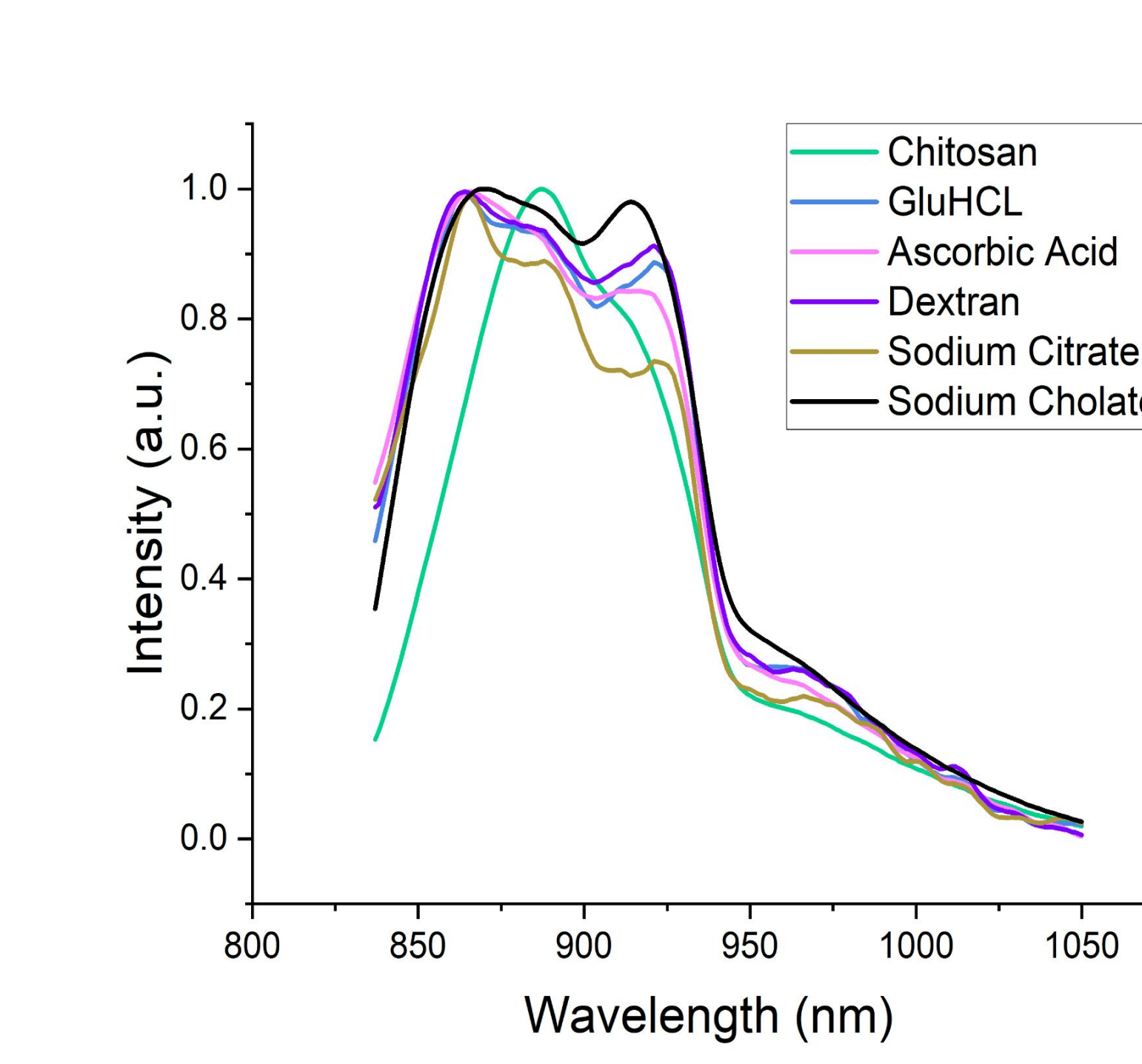
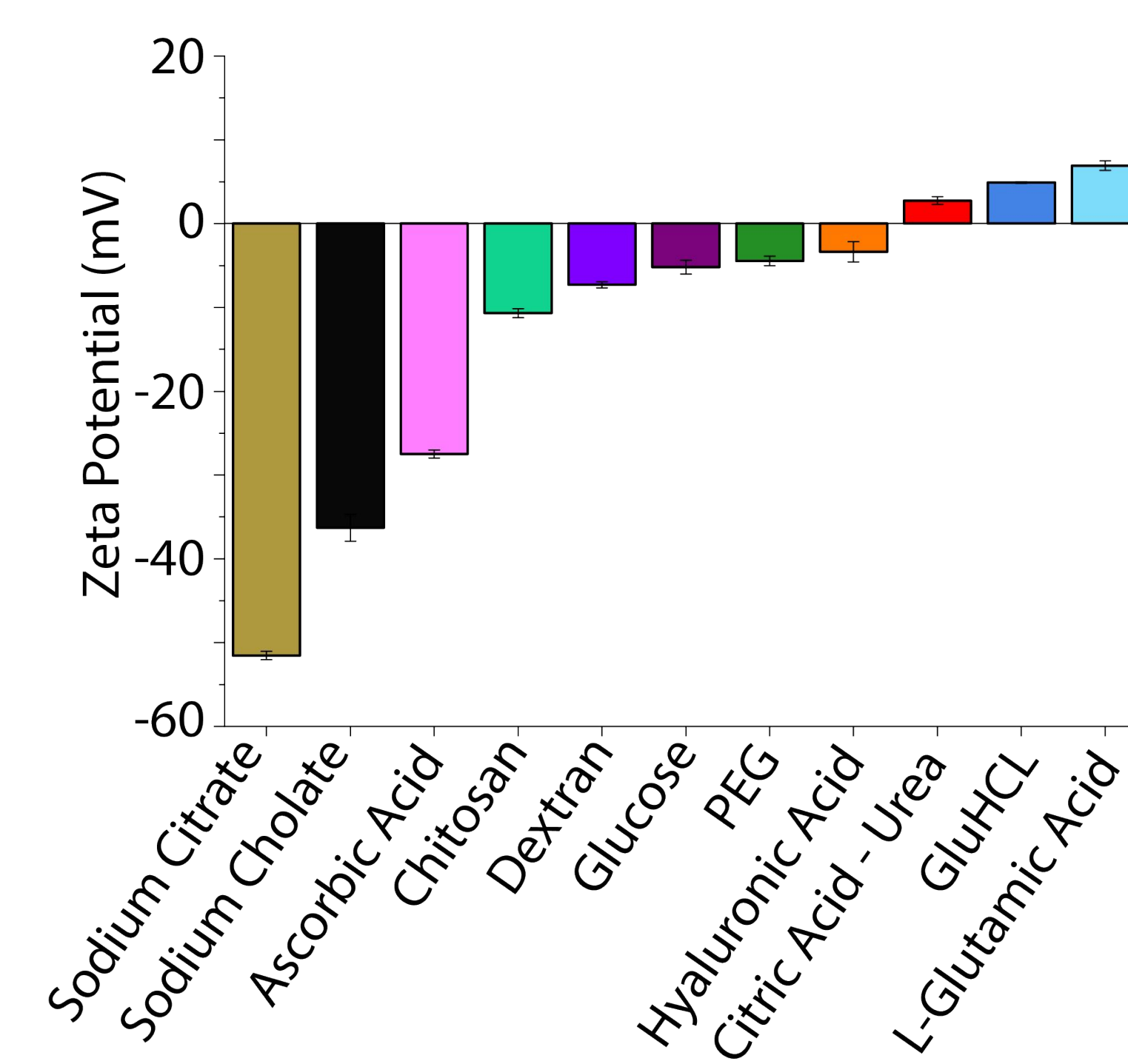
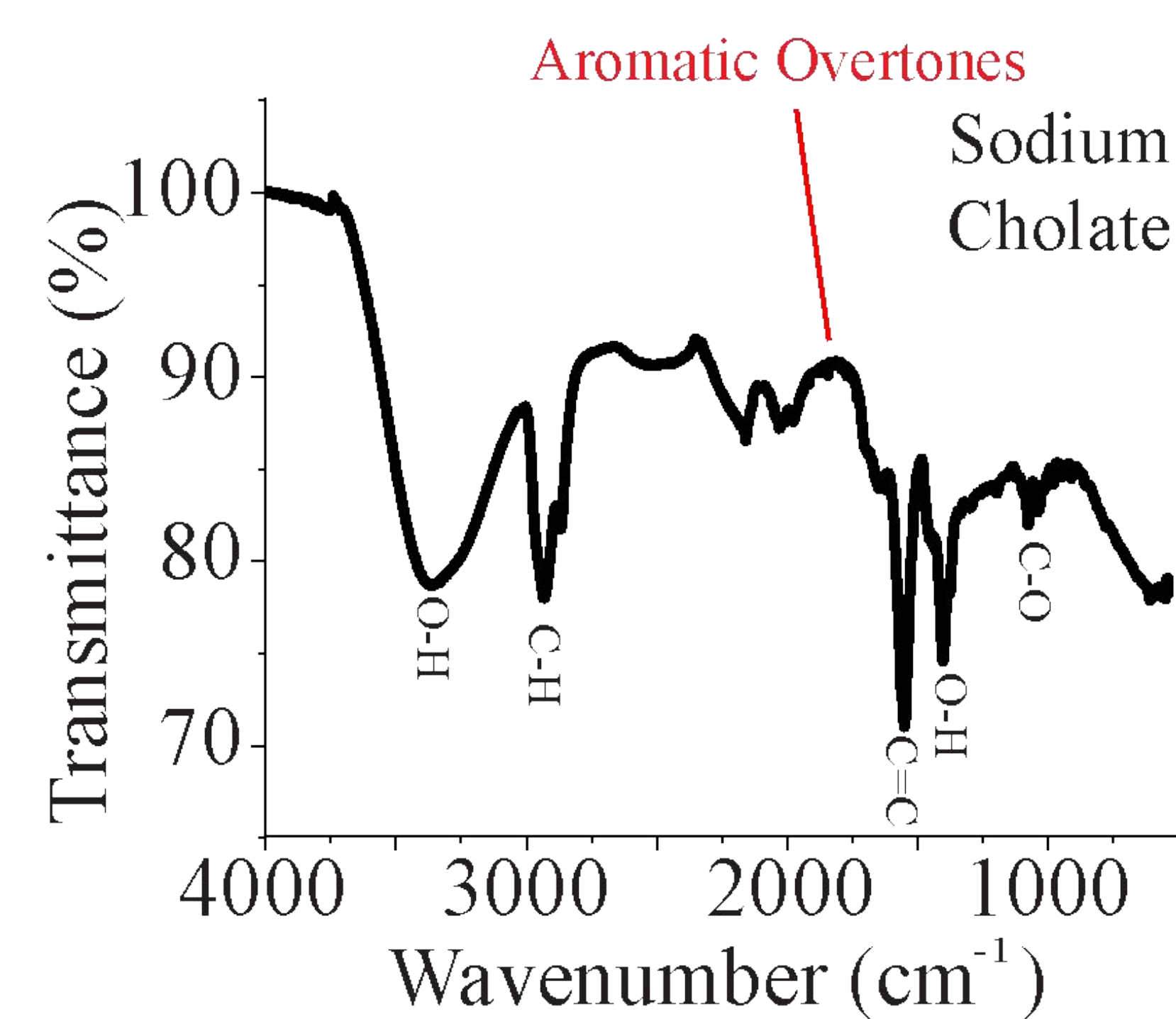
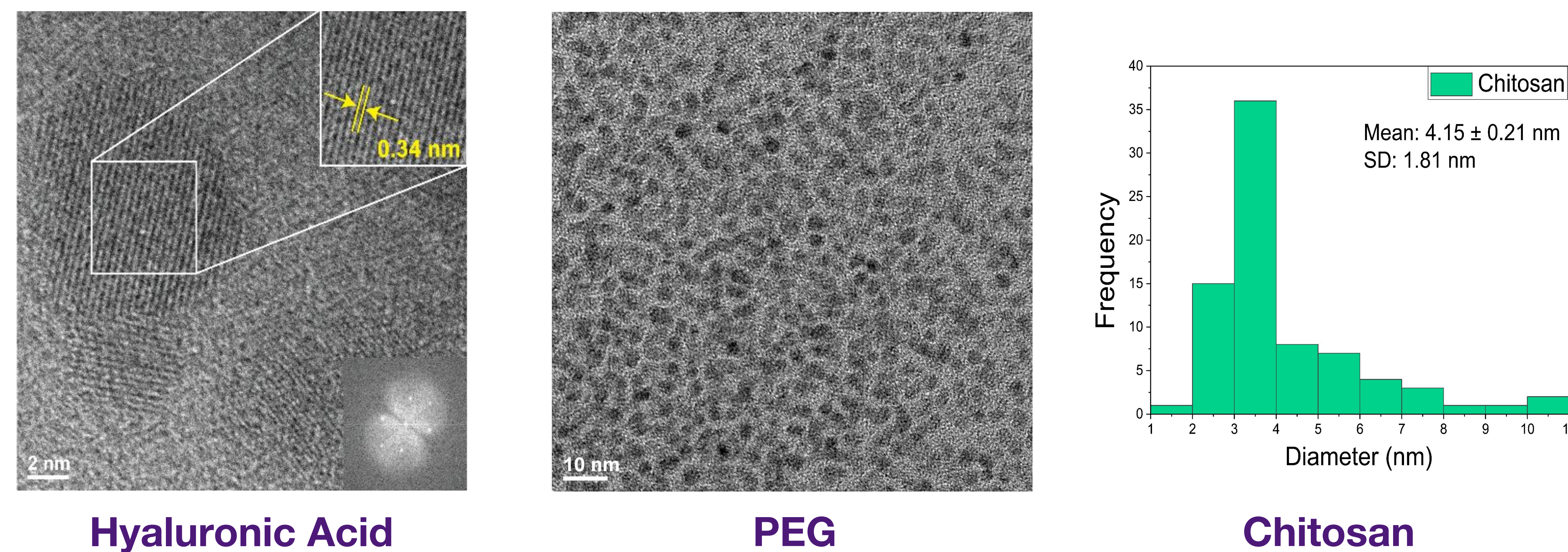


- First to survey an extensive set of eleven common molecular precursors
- Scalable microwave-assisted carbonization
- GQDs with diverse physical and NIR optical properties
- *In-vitro* imaging to confirm cell-internalization of GQDs
- Foundation for tailoring these materials for biomedical imaging applications

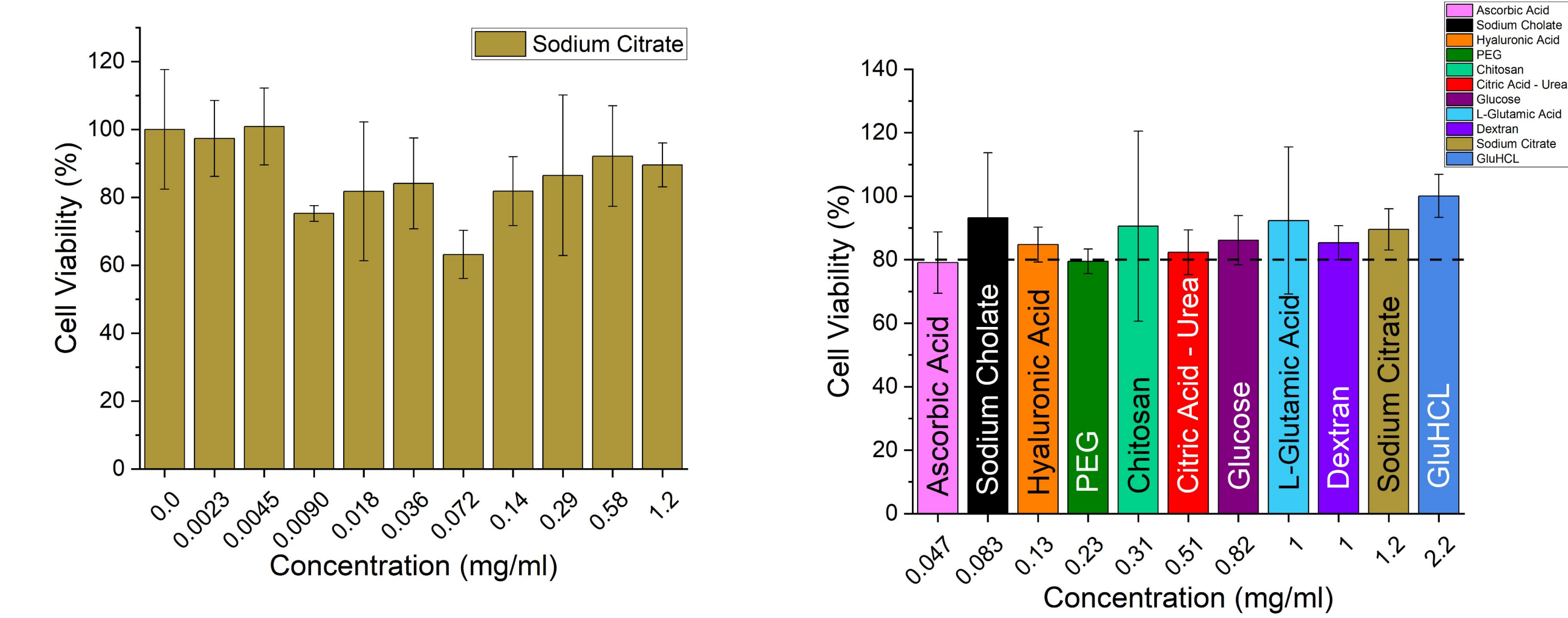
Synthesis Process



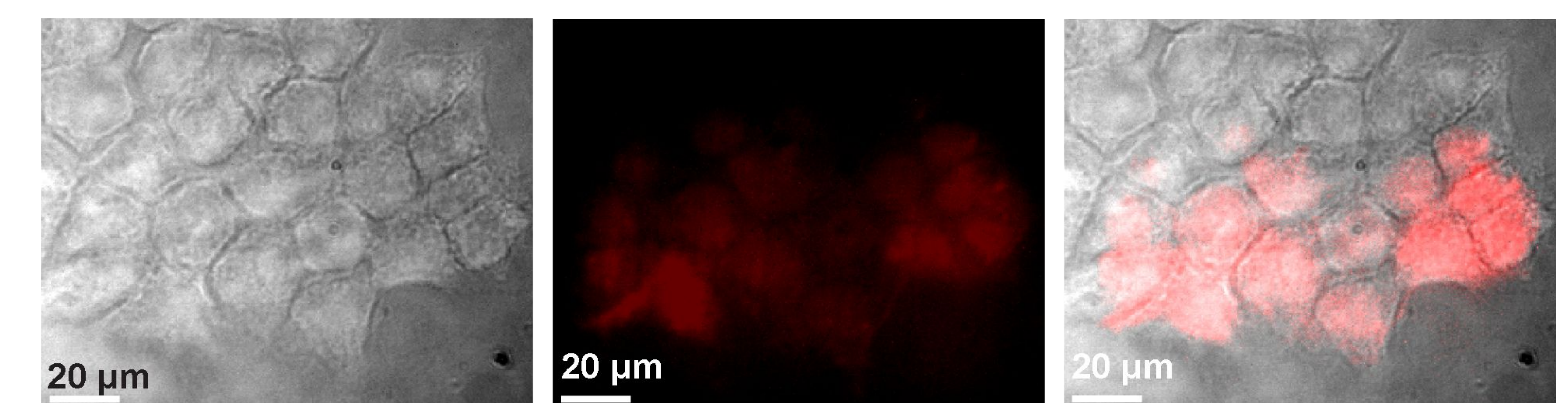
Characterization



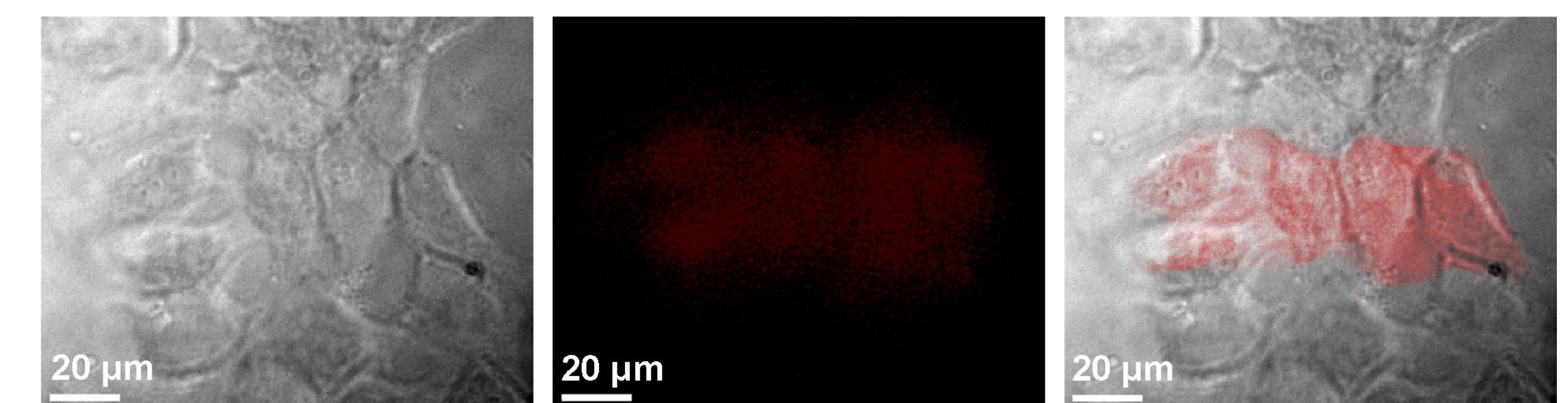
Biocompatibility Assay



Cellular Imaging



Sodium Citrate



L-Glutamic Acid

Conclusion

- Precursor choice controls size (2.8–13.5 nm), surface chemistry (–OH, –COOH, C=O, –NH₂), and zeta potential (–50 to +7 mV), directly tuning stability, solubility, biocompatibility, and potential for surface functionalization.
- All GQDs demonstrate visible and NIR fluorescence with structure and excitation-dependent spectra in the visible and strong precursor-dependent spectral features in the NIR.
- All 11 GQDs show >80% cell viability in HEK-293 cells and efficient cellular internalization
- Diverse surface functional groups yield NIR-emissive GQDs with tunable optical and chemical properties that can be tailored for specific biological functions.
- The spectral diversity of GQDs further allows multimodal imaging and simultaneous tracking of multiple processes within a single system in the NIR with high fluorescence tissue penetration depth

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