pH-based Cancer Detection by Graphene Quantum Dots

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SciCom
Let's Talk Science

Early and Accurate Detection

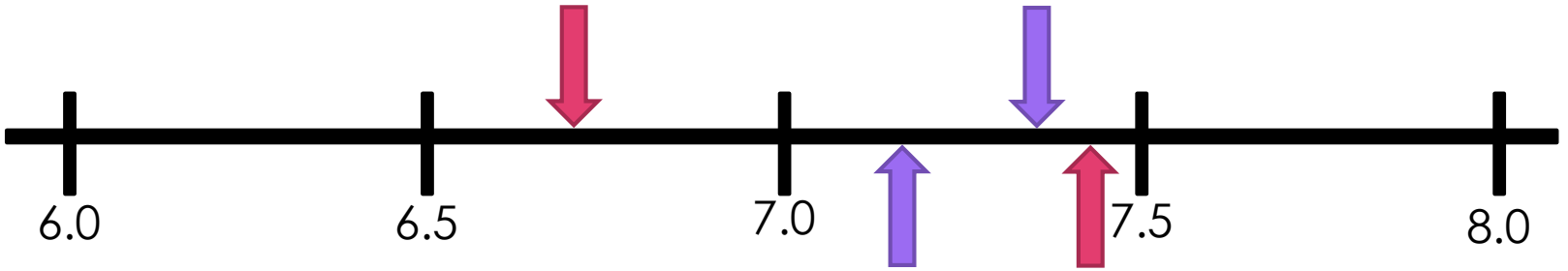
IN 2020:

- OVER 1.8 MILLION CANCER DIAGNOSES IN THE US
- MORE THAN 600,000 DEATHS

---Early and accurate detection significantly increases survival rates---

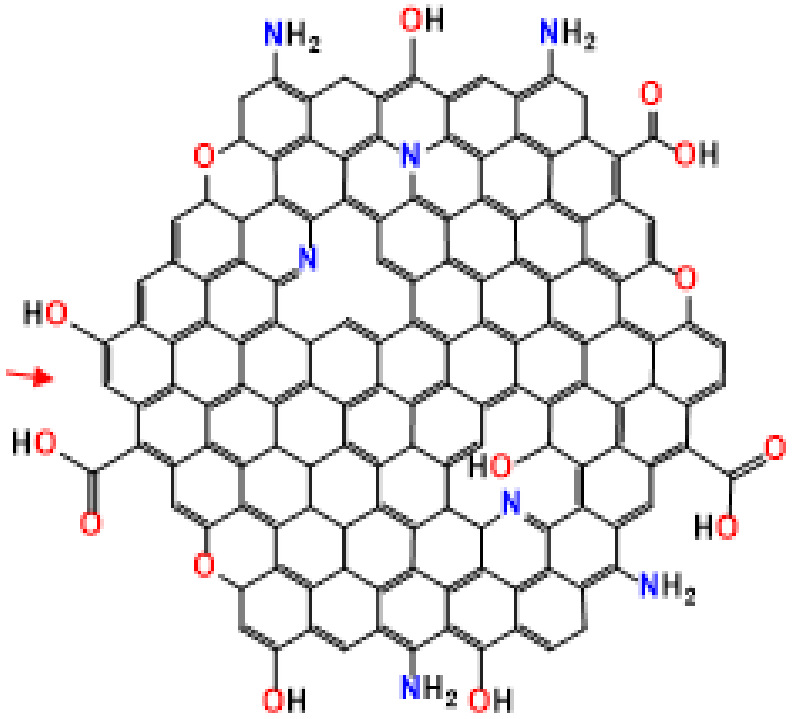
The Acidic Environment

	Healthy Cells	Cancer Cells
Intracellular Environment	pH 7.2	pH 7.3-7.6
Extracellular Environment	pH 7.35-7.45	pH 6.4-7.0



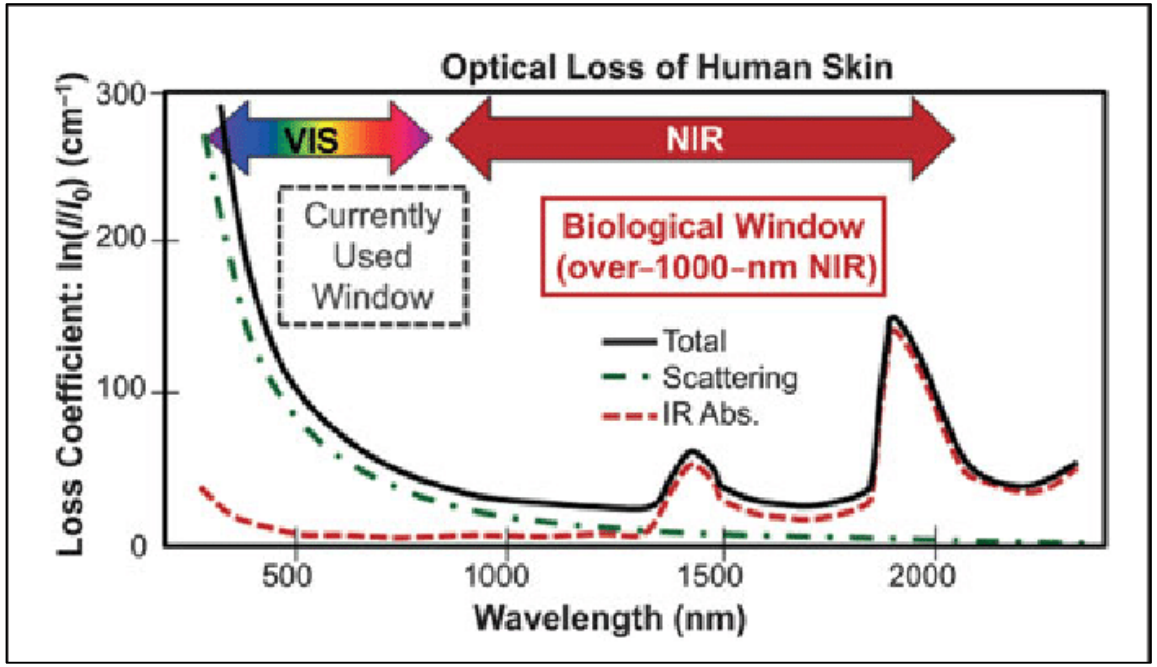
What is a Quantum Dot?

- Man made crystals measuring a few nanometers in size
- Unique optical and electronic properties differing from larger particles
- Uses in:
  - Transistors
  - Solar Cells
  - Quantum Computing
  - Medical Imaging

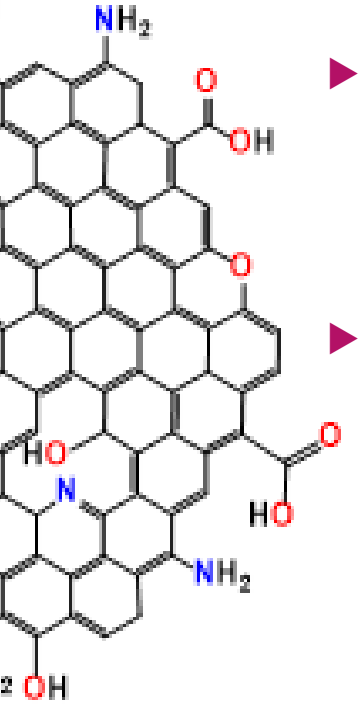


Fluorescence Imaging

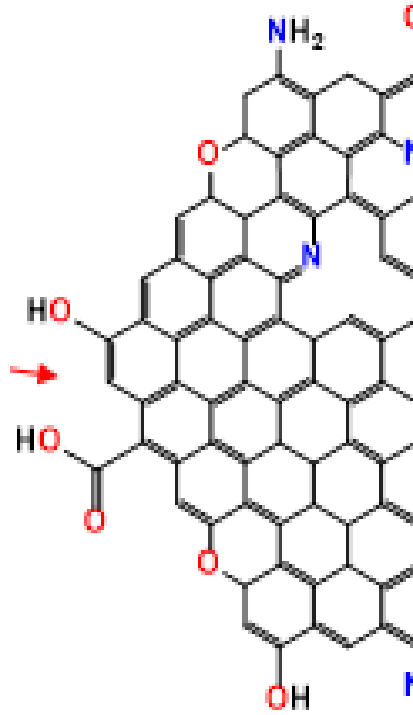
- Fluorescence can serve as a detection mechanism for nanoparticles in:
  - Drug delivery
  - Cancer sensing
- Fluorescence is advantageous for cancer sensing: allows for non-invasive imaging-based diagnostics
- Near-Infrared fluorescence is advantageous for biological sensing: near-infrared light penetrates several cm of biological tissue: *in vivo* detection.



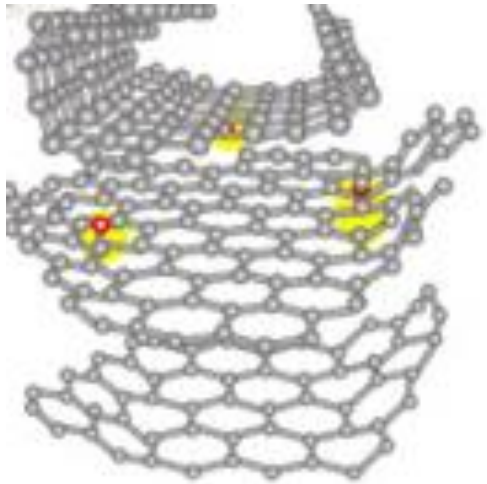
Why?



- **Goal**
  - To analyze the fluorescence change with pH in the visible and infrared range of various forms of Graphene Quantum Dots (GQDs) to determine their use in cancer imaging and drug delivery.
- **Impact**
  - If a relationship can be found between the spectra and pH within the biological range of pH6.00-8.00, these particles be utilized as a highly accurate cancer detection method, in addition to their many other applications for biological imaging

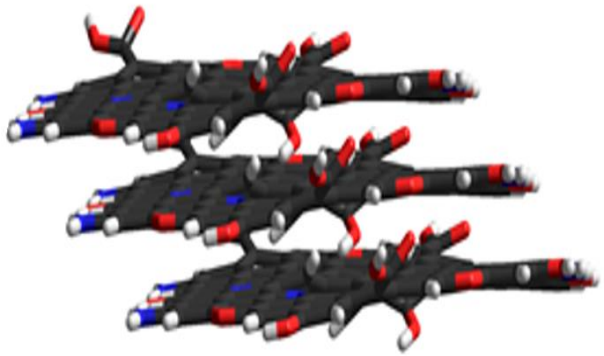


Reduced Graphene Oxide Quantum Dots (RGQDs)



UV

Sodium Hypochlorite

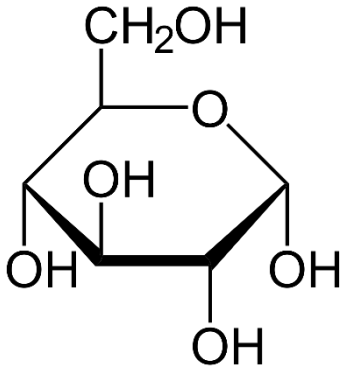


Reduced Graphene Oxide (RGO)

RGQDs

Synthesized by Veronica Lyle

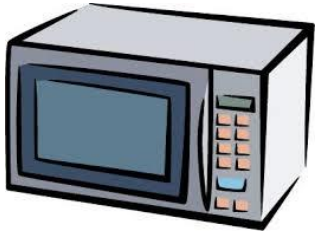
Glucose Graphene Quantum Dots (GGQDs)

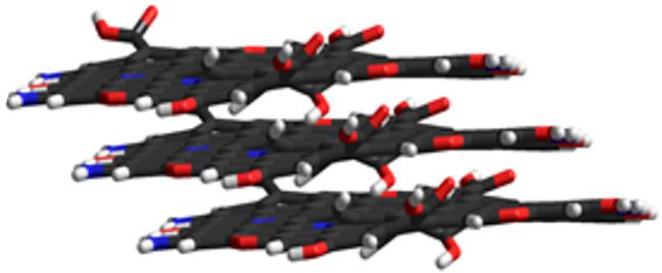


Glucose

Ammonia

Microwave

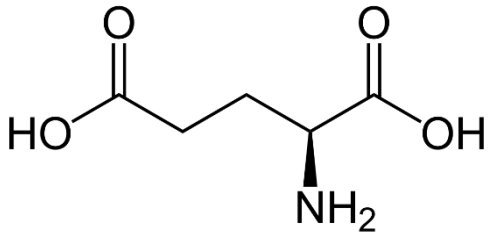




GGQDs

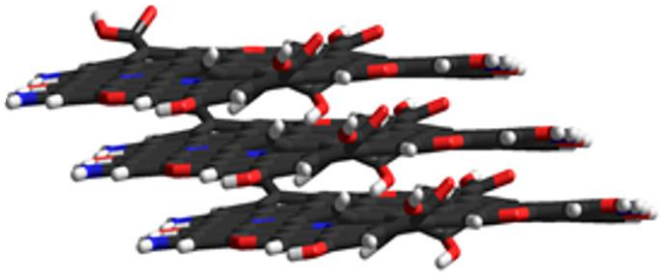
Synthesized by Matt Dadet

L-Glutamic Acid Graphene Quantum Dots (LGGQDs)



L-Glutamic Acid

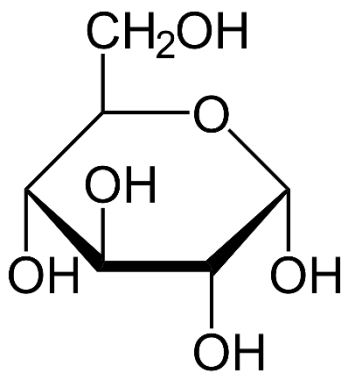
Heat



LGGQDs

Synthesized by Matt Dadet

Aluminum Doped Reduced Graphene Oxide Quantum Dots (Al-RGQDs)



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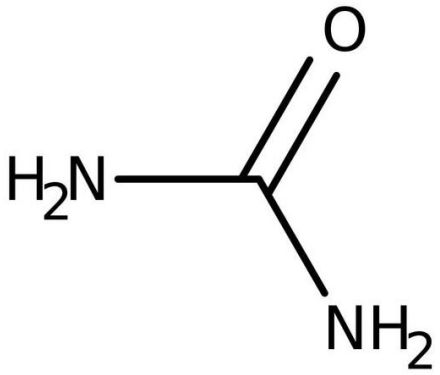
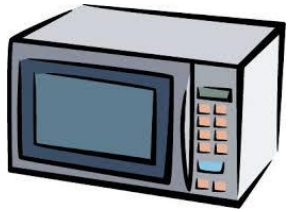
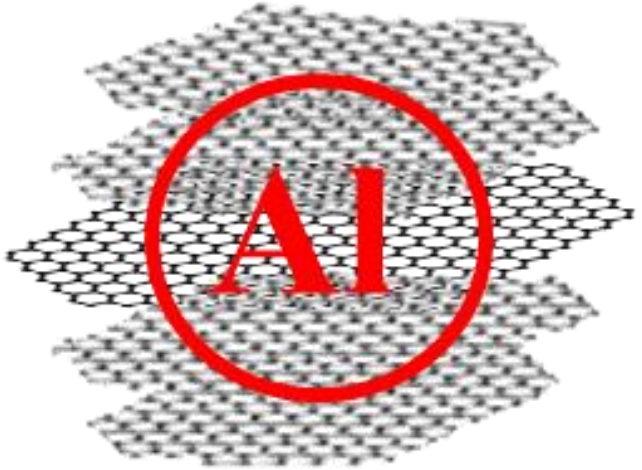


Glucose + Urea

H2O + Aluminum



Ultrasound+ Microwave



Al-RGQDs

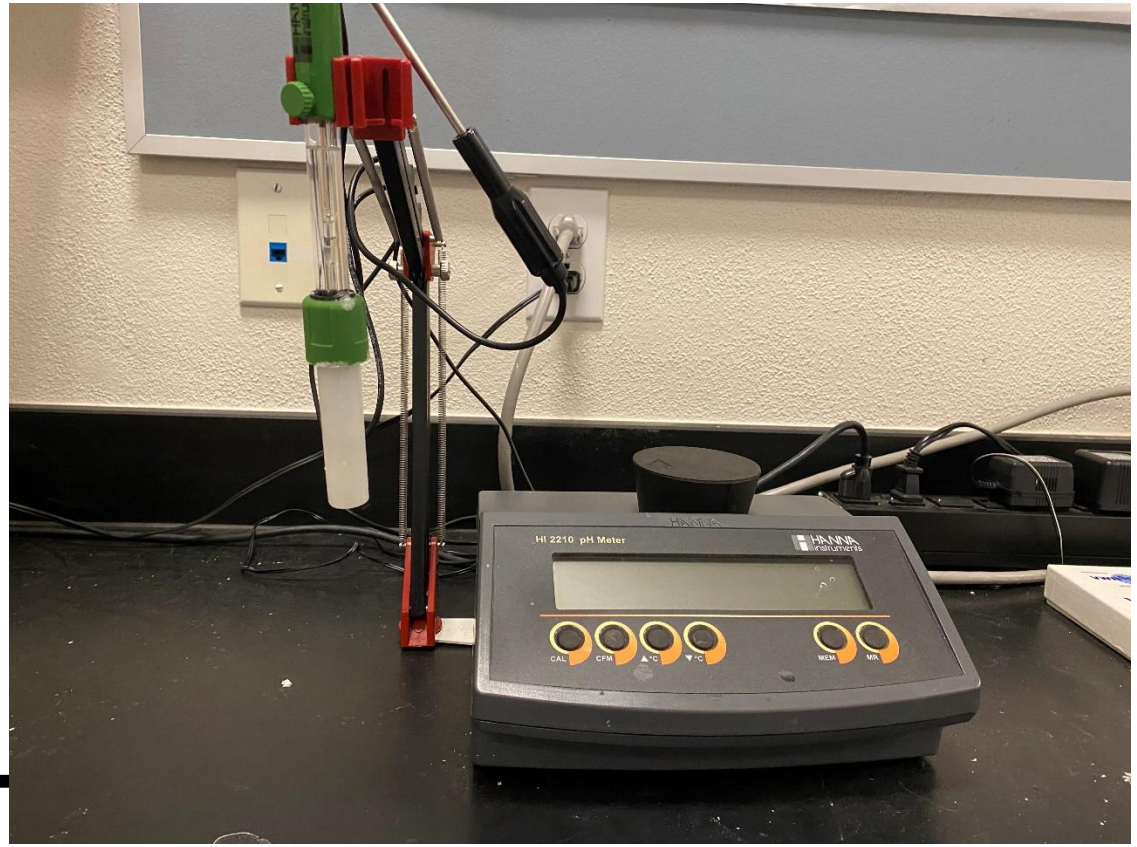
Synthesized by Dr. Roberto Gonzalez Rodriguez

Why These 4?

THEY ALL FLUORESCE IN THE INFRARED RANGE

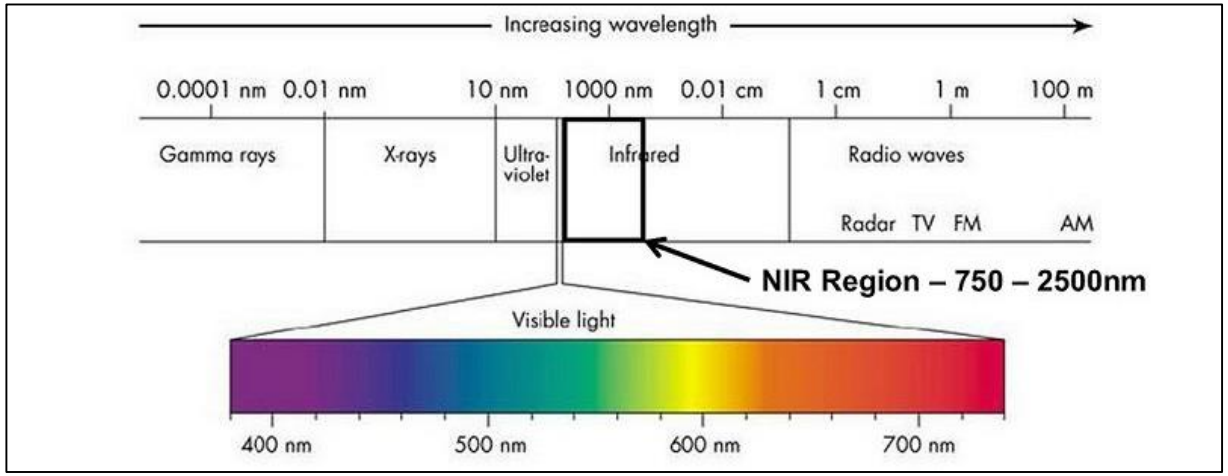
pH Adjustment

- Using the Hanna HI2210 pH Meter, detected initial pH
- Added .075M NaOH or HCl in 5µL increments to adjust pH ∓ 0.25 for each subsequent measurement



Imaging

- To collect visible spectra, utilized the Horiba spectral array collecting from 440-700nm
- To collect infrared spectra, utilized a combination of the symphony II spectral array, an 808nm laser, and a 400nm laser collecting from 800-1100nm



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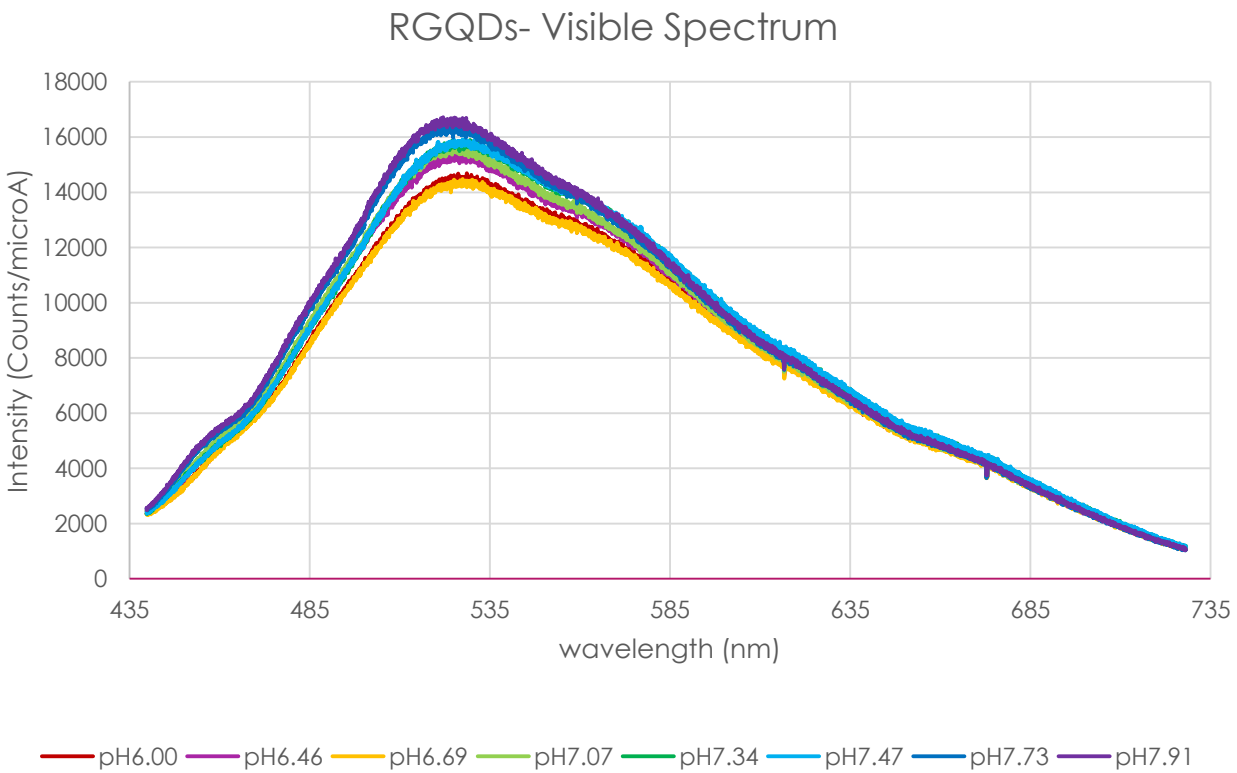

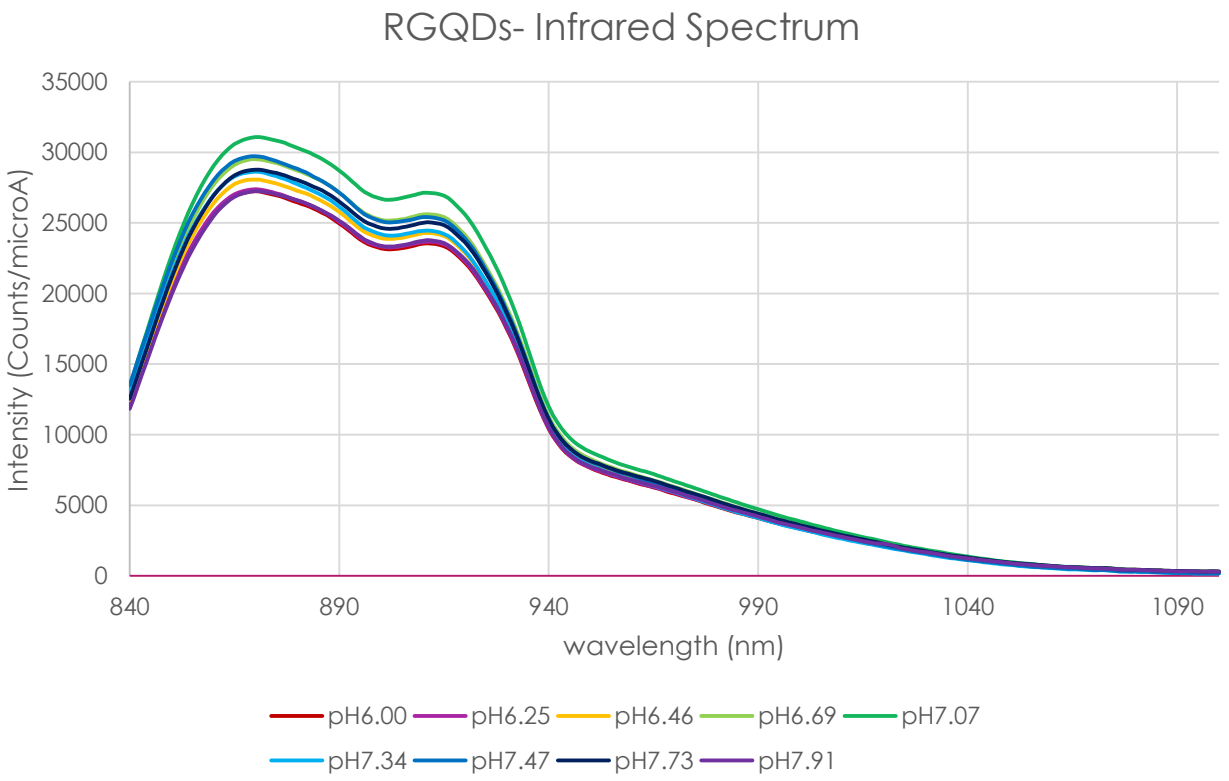

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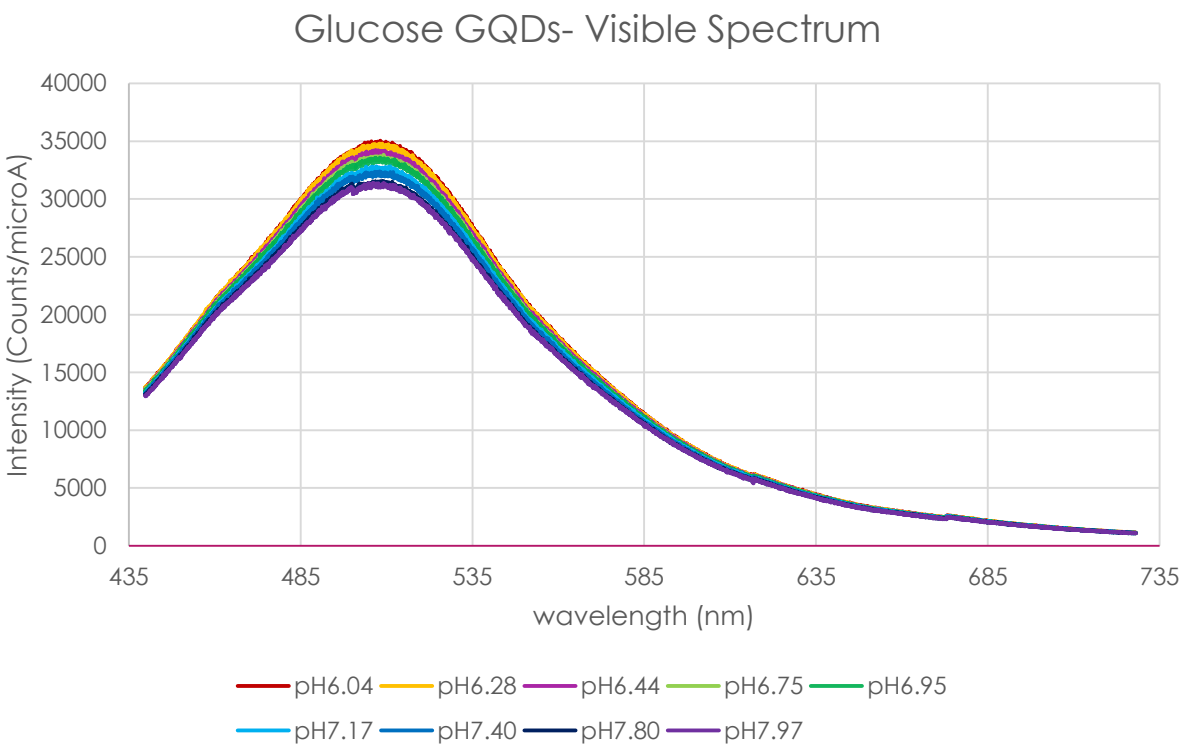

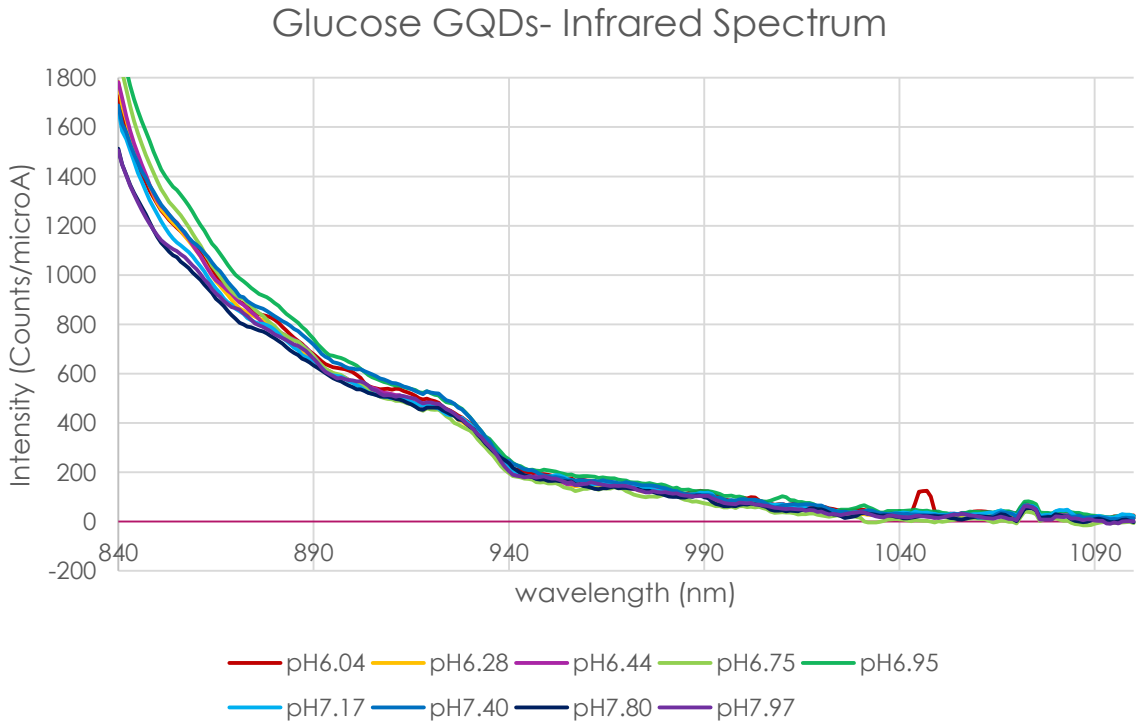

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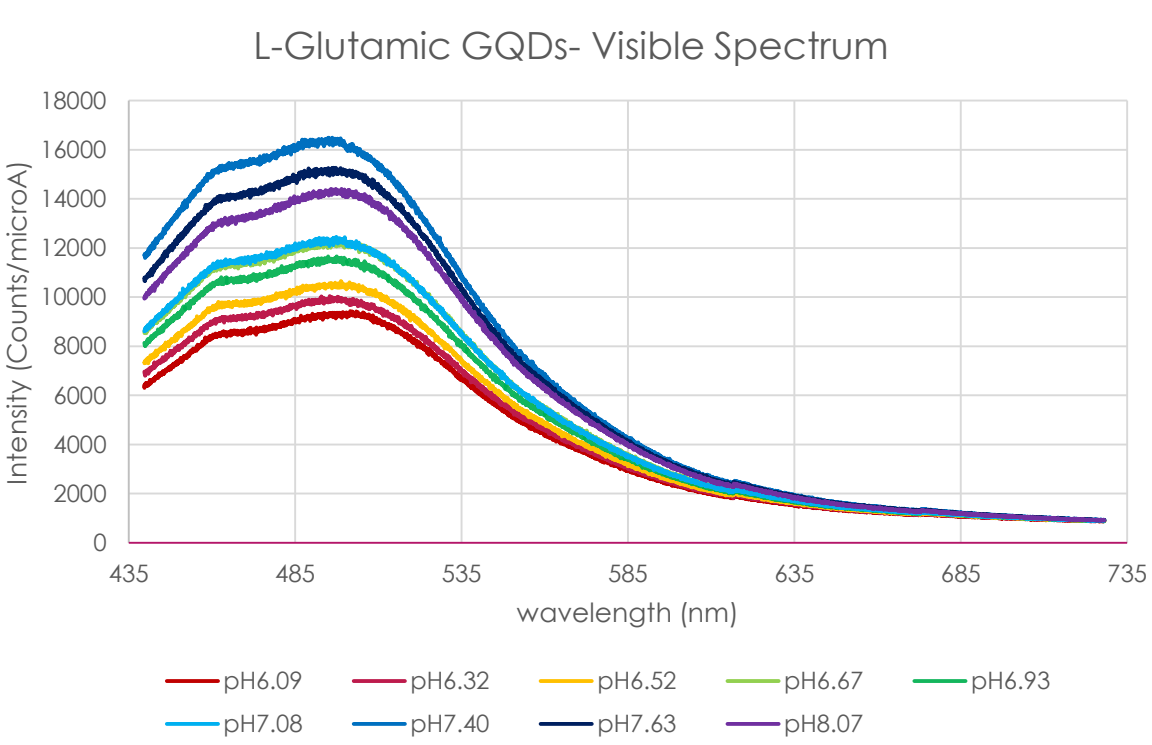

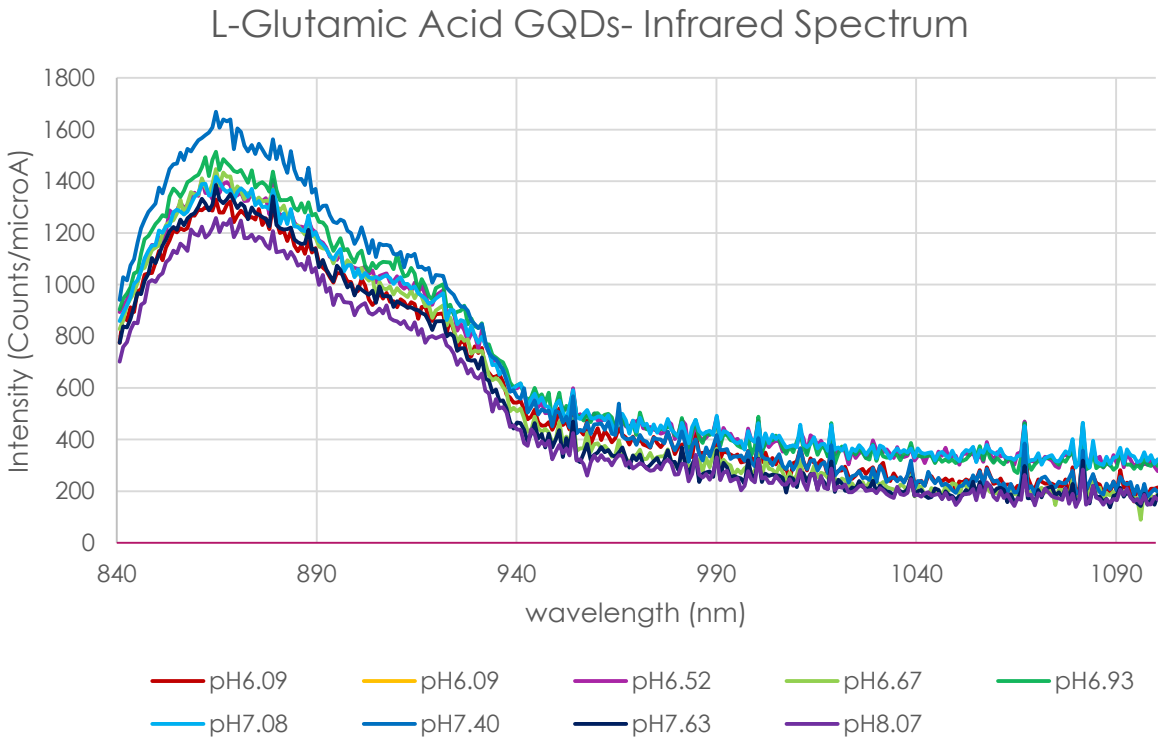

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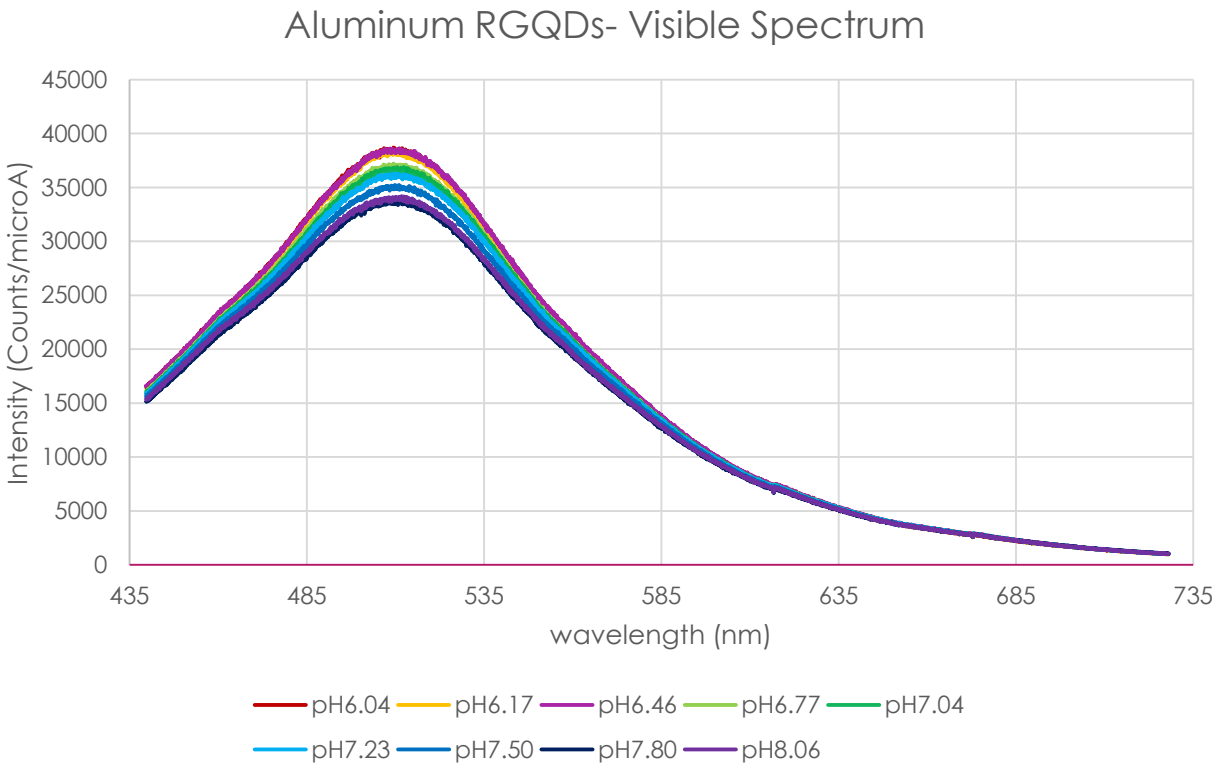
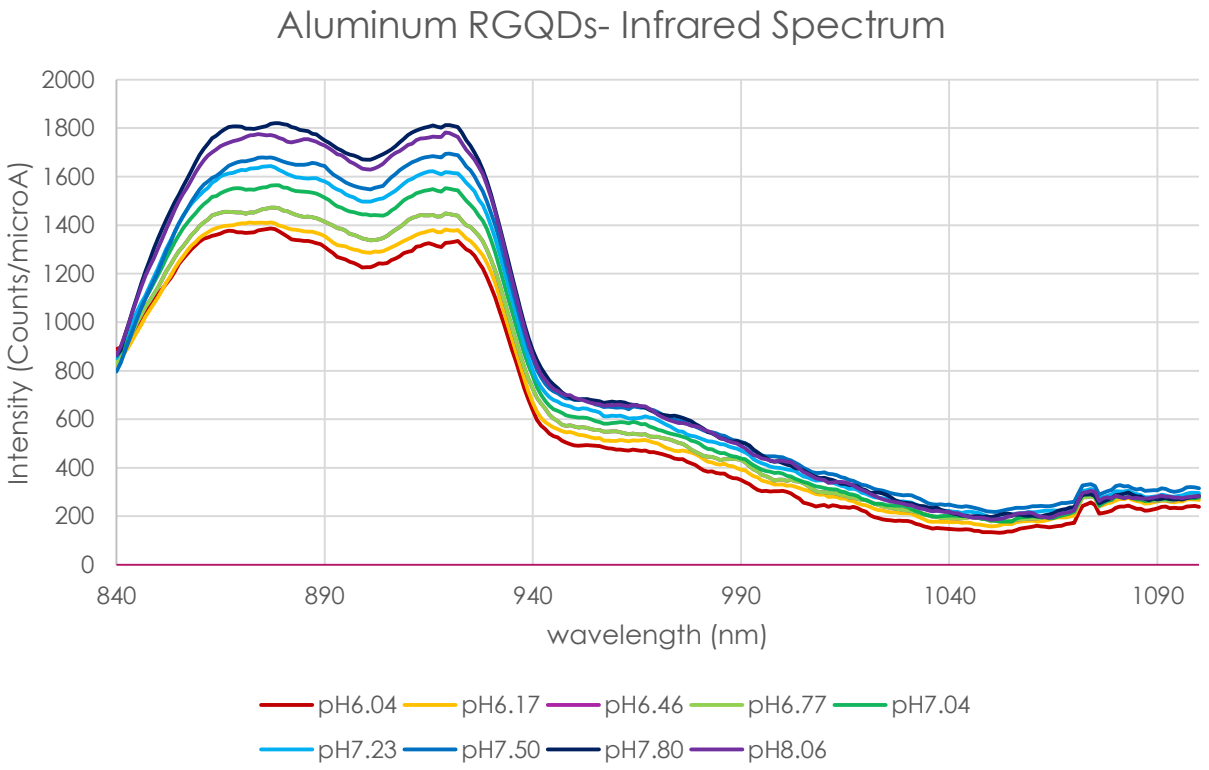


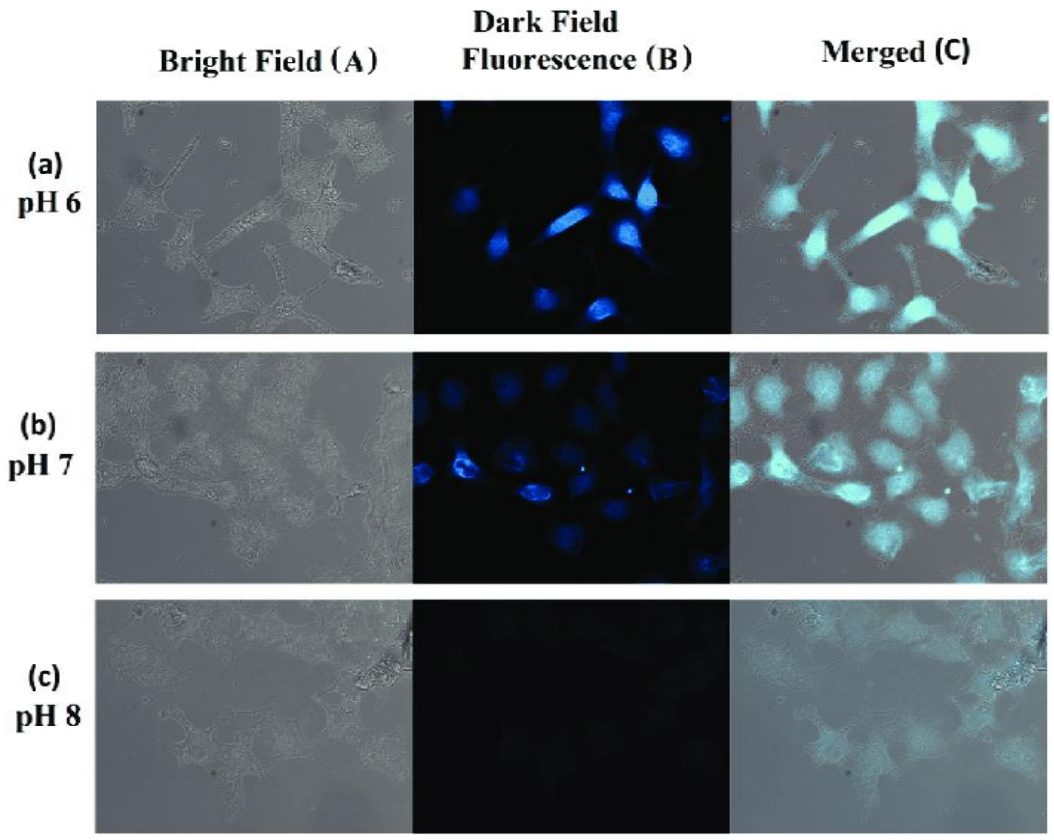


Conclusions

No Detectable pH Sensitivity	Visible pH Sensitivity	Infrared and Visible pH Sensitivity
RGQDs	GGQDs, LGGQDs	Al-RGQDs

Next Steps

- Cytotoxicity studies for GGQDs and LGGQDs
- Live Cell Imaging Studies (example right)
  - Time Lapsed
  - Cancerous and Noncancerous Cell Lines
  - Collect data regarding:
    - Internalization
    - Excretion
    - Fluorescence



References

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Q&A