Tweaking, Poking, and Shining Electrons on Polydopamine Nanoparticles (PDNP): An Undergraduate Research Nano Bootcamp Experiment

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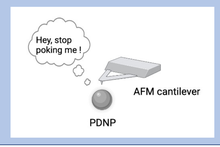
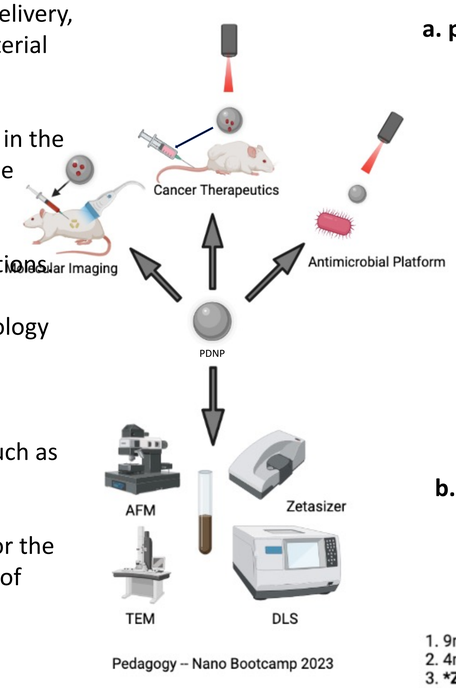


Background

Nanoscience has revolutionary applications in drug delivery, molecular imaging, cancer therapeutics, and antibacterial platforms.[1]

One viable nanomaterial with promising applications in the biomedical sciences are the bioinspired polydopamine nanoparticles (PDNP).

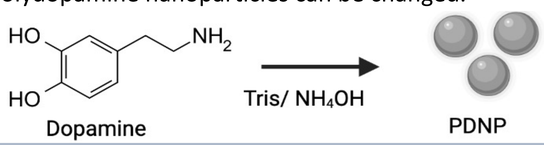
They are easy to make and don't require harsh conditions. Hence, they are a perfect nanoparticle model for undergraduates to learn valuable skills in nanotechnology from.



Pedagogy -- Nano Bootcamp 2023

Synthesis:
PDNP is synthesized by adding a base to dopamine such as Tris buffer or ammonium hydroxide (NH_4OH).[2]

By changing either the pH, volume of a base added, or the initial concentration of dopamine used, the final size of polydopamine nanoparticles can be changed.[3,4,5]



Purpose

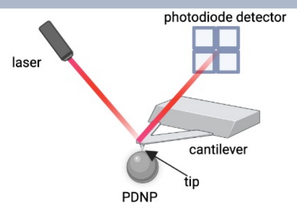
The aim was to tweak PDNP synthesis parameters to generate PDNP of different sizes by changing the following parameters:

- pH of a base added such as Tris buffer
- initial dopamine concentration
- volume of a base added such as NH_4OH

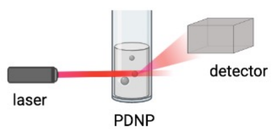
Size was determined using instrumentation such as Atomic Force Microscopy (AFM), Dynamic Light Scattering (DLS), Transmission Electron Microscopy (TEM), and Zetasizer.

Instrumentation

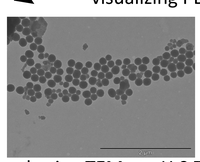
TEM shines electrons on the PDNP sample for imaging and is useful for determining PDNP size.[7]



AFM uses a laser deflection system to measure forces for visualizing PDNP.[6]



DLS uses Brownian motion (random movement) of PDNP to indirectly measure its diameter via the measurement of light scattered by PDNP.[9]

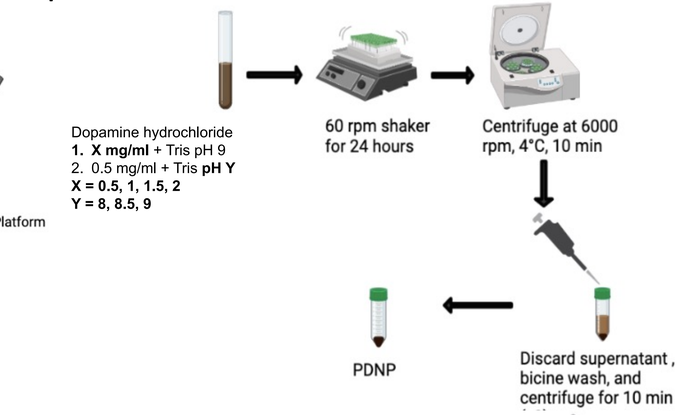


PDNP imaged using TEM at pH 9 Tris buffer, 0.5 mg/ ml dopamine hydrochloride concentration

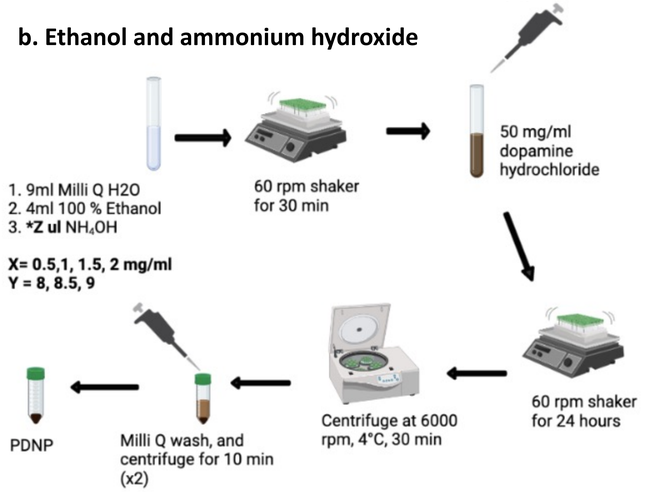
Zetasizer measures the surface charge of PDNP as an indicator of stability.[8]

Methodology

a. pH and concentration

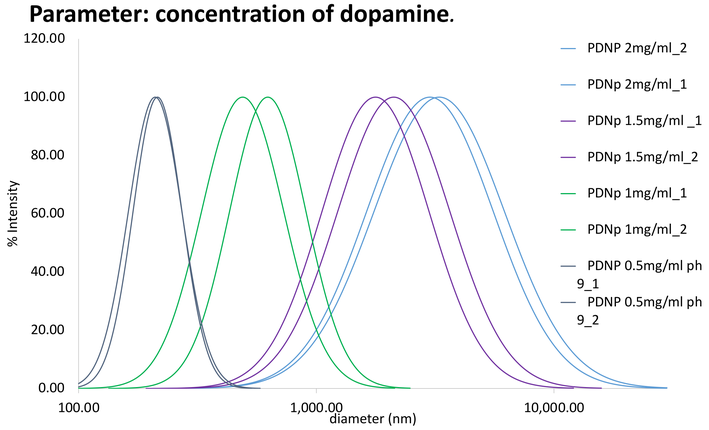


b. Ethanol and ammonium hydroxide



Results

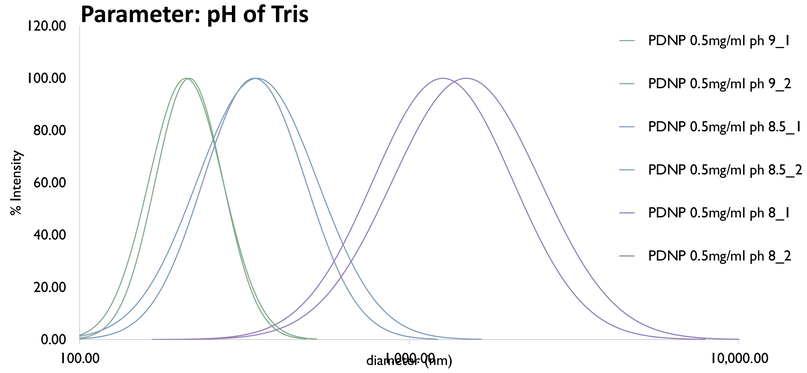
Parameter: concentration of dopamine.



Summary: As the concentration of dopamine *increases*, the diameter of PDNP *increases.*

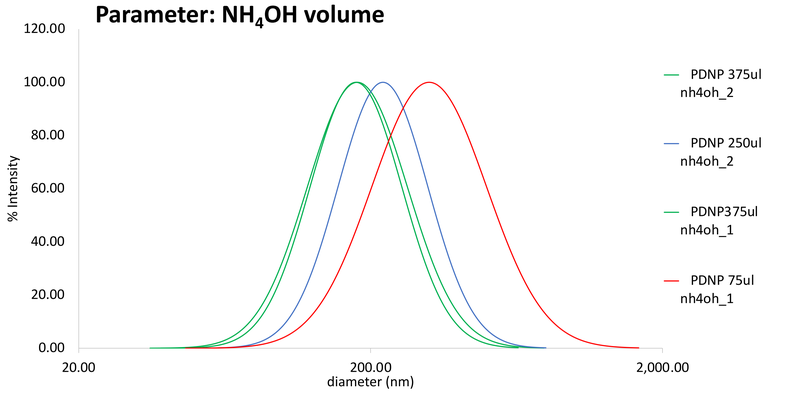
Results

Parameter: pH of Tris



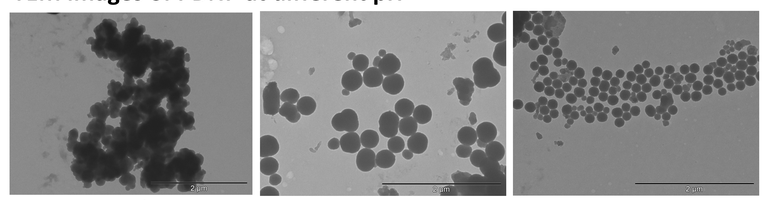
Summary: As the pH of Tris buffer *increases*, the diameter of PDNP *decreases*.

Parameter: NH_4OH volume



Summary: As the volume of NH_4OH *increases,* the diameter of PDNP *decreases.*

TEM images of PDNP at different pH



pH 8 Tris , 0.5mg/ml dopamine **pH 8.5** Tris , 0.5mg/ml dopamine **pH 9** Tris, 0.5mg/ml dopamine

Summary: as pH of Tris increases, PDNP is less aggregated and smaller in

Future Directions

This experiment I developed is a part of a series of experiments of the Nano Bootcamp that will be introduced to undergraduate students through a newly launched Summer Nano Bootcamp 2023.

To collect student feedback and optimize the PDNP experiment for future

References

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