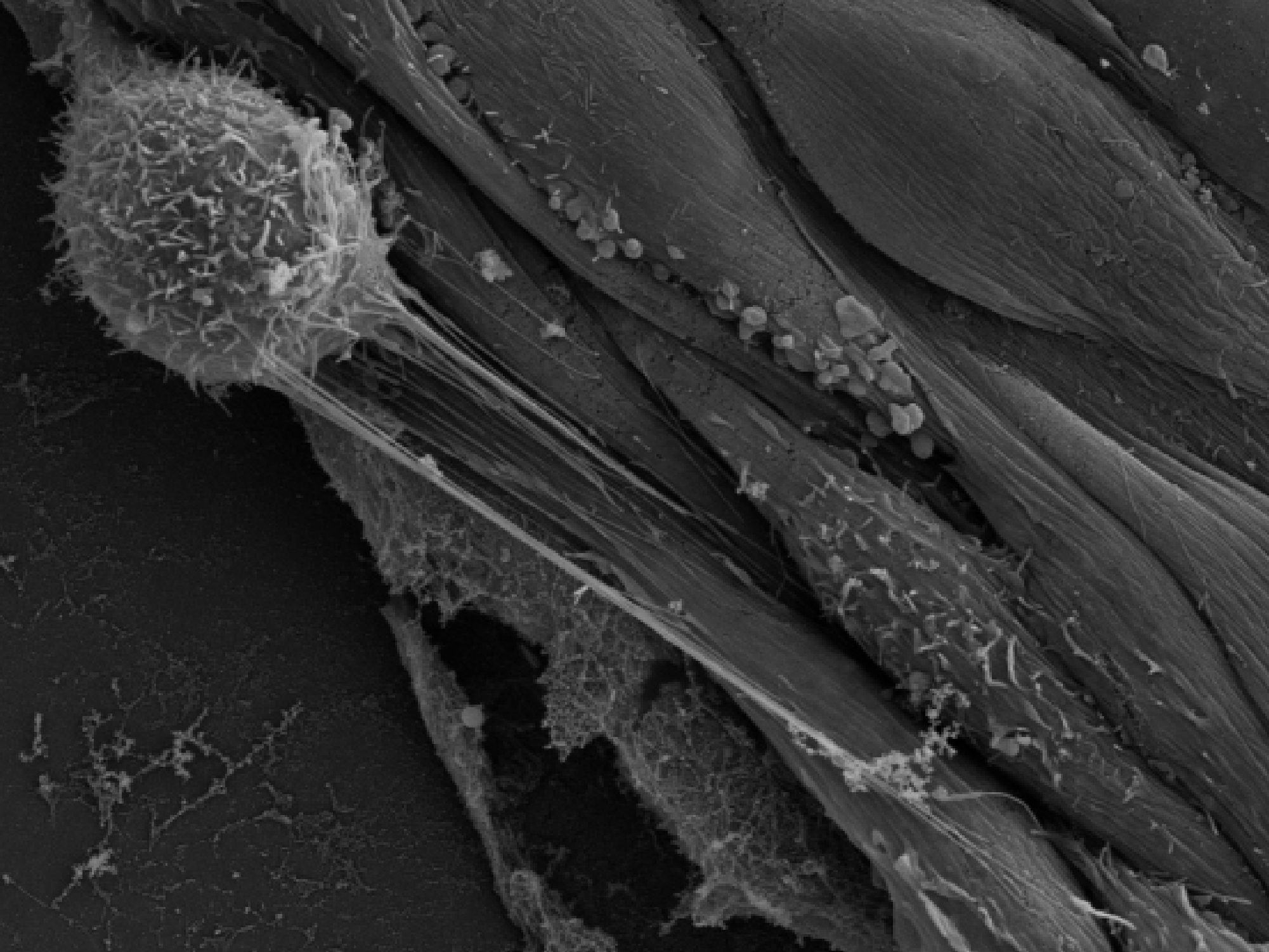
Bachelor Thesis 2016

Radiosensitization using gold nanoparticles

Lies Deceuninck en Hannelore Verhoeven

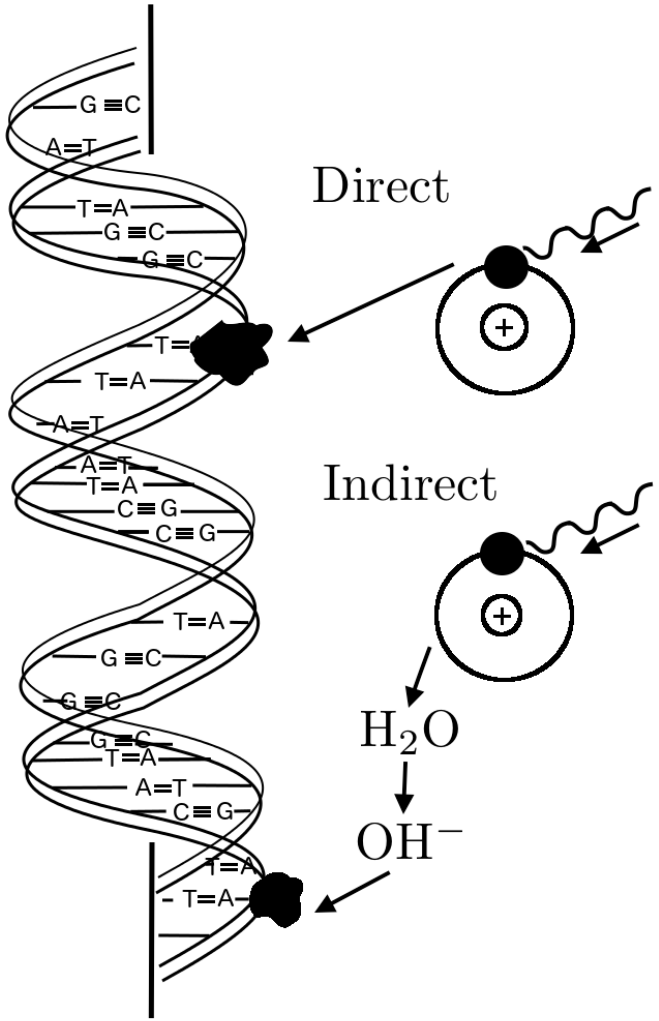
Assistents: Bert De Roo
Mattias Vervaele
Professor: Chris Van Haesendonck



DNA damage using ionizing radiation

- Chemotherapy
- Surgery
- **Radiation therapy**

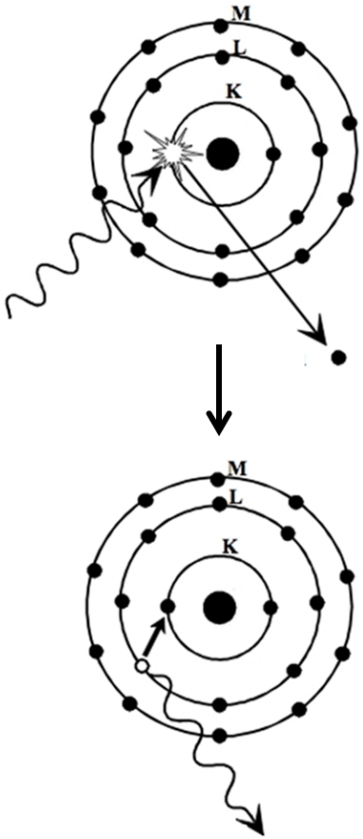
  Energy $\sim$ MeV



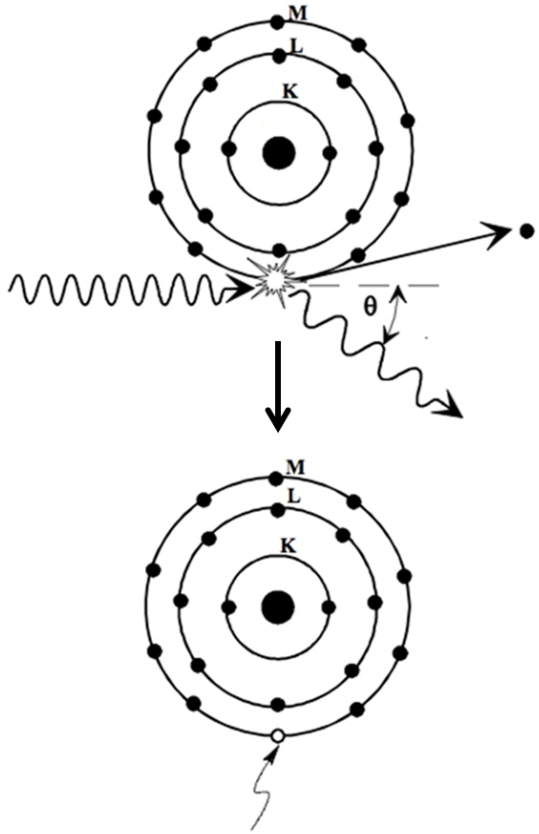
Source: https://chem.kuleuven.be/veiligheid/info/ioniserende-st.htm

Radiosensitization of cancer cells with gold nanoparticles (GNP) E ~ keV

Photoelectric absorption

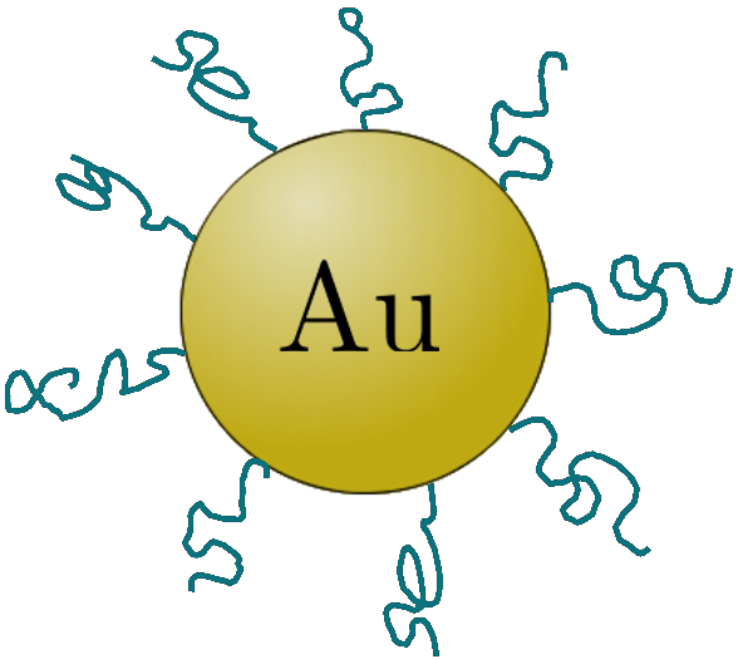


Compton effect

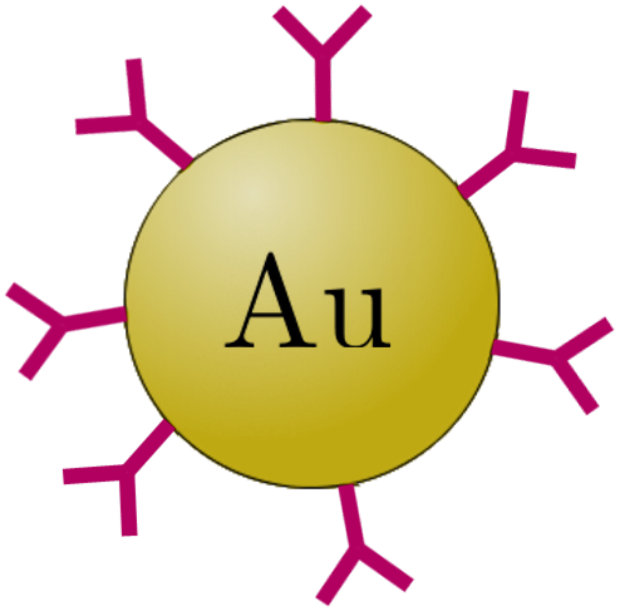


Targeting of the GNP to the tumor

Passive targeting
PEG coating



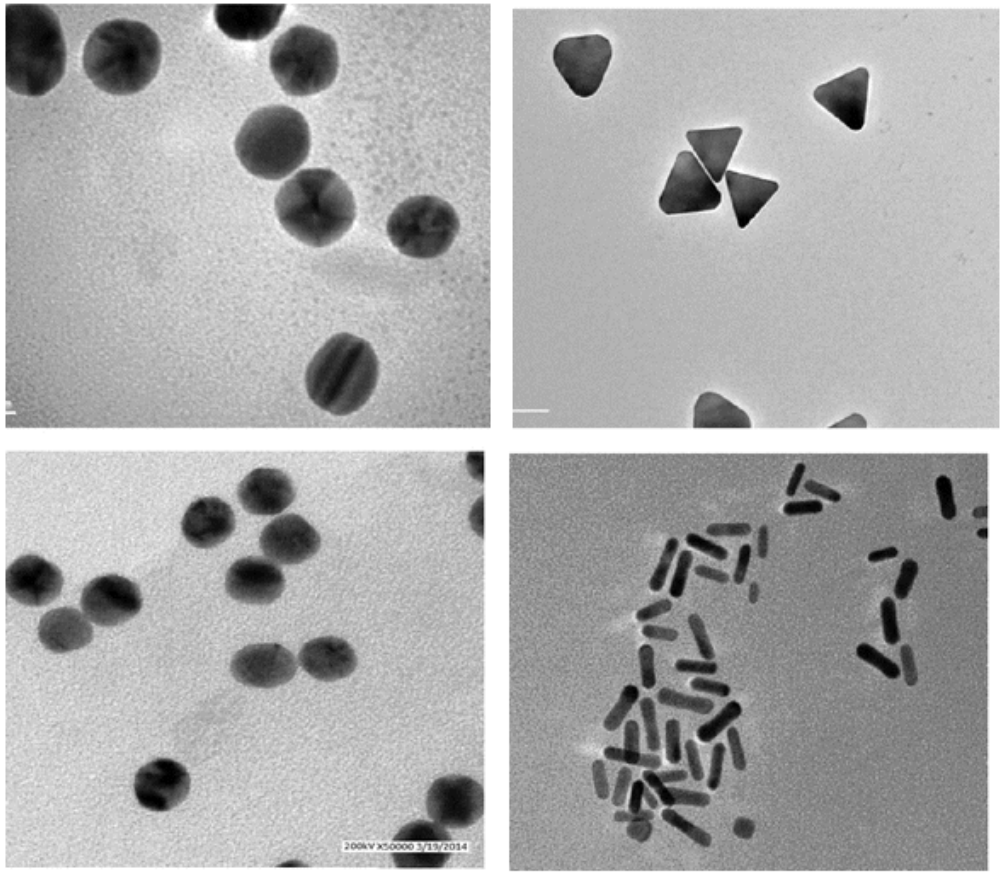
Active targeting
Antibodies



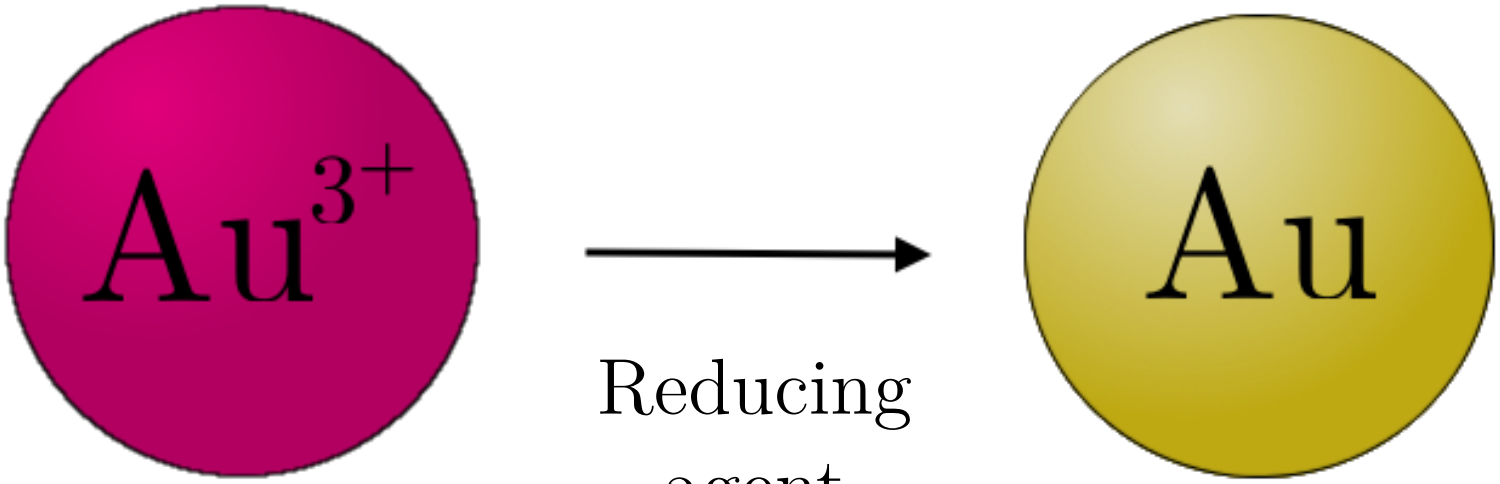
Overview Project

Radiosensitization of cancer cells using gold nanoparticles

1. Synthesis
2. Characterization
3. Radiosensitization

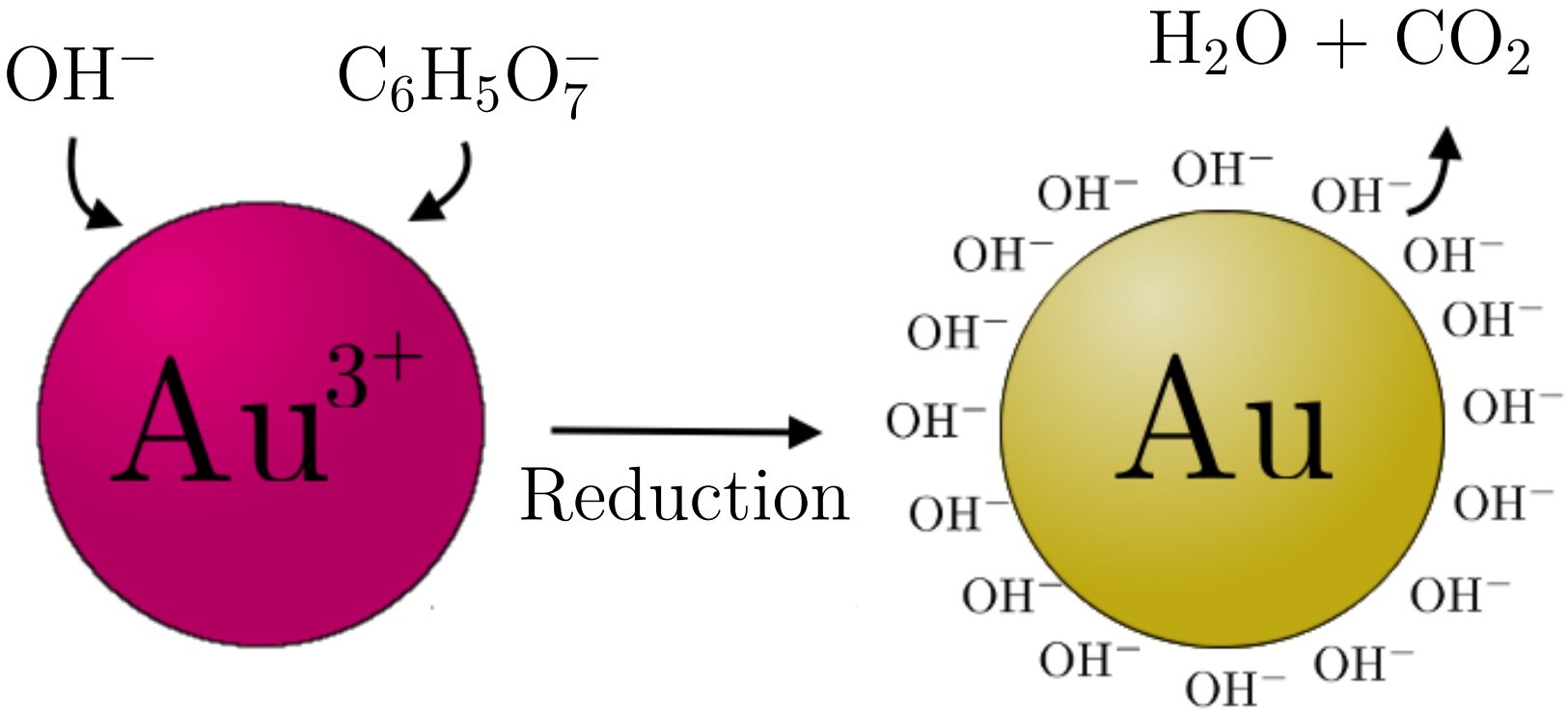


Reduction of gold ions to form GNP



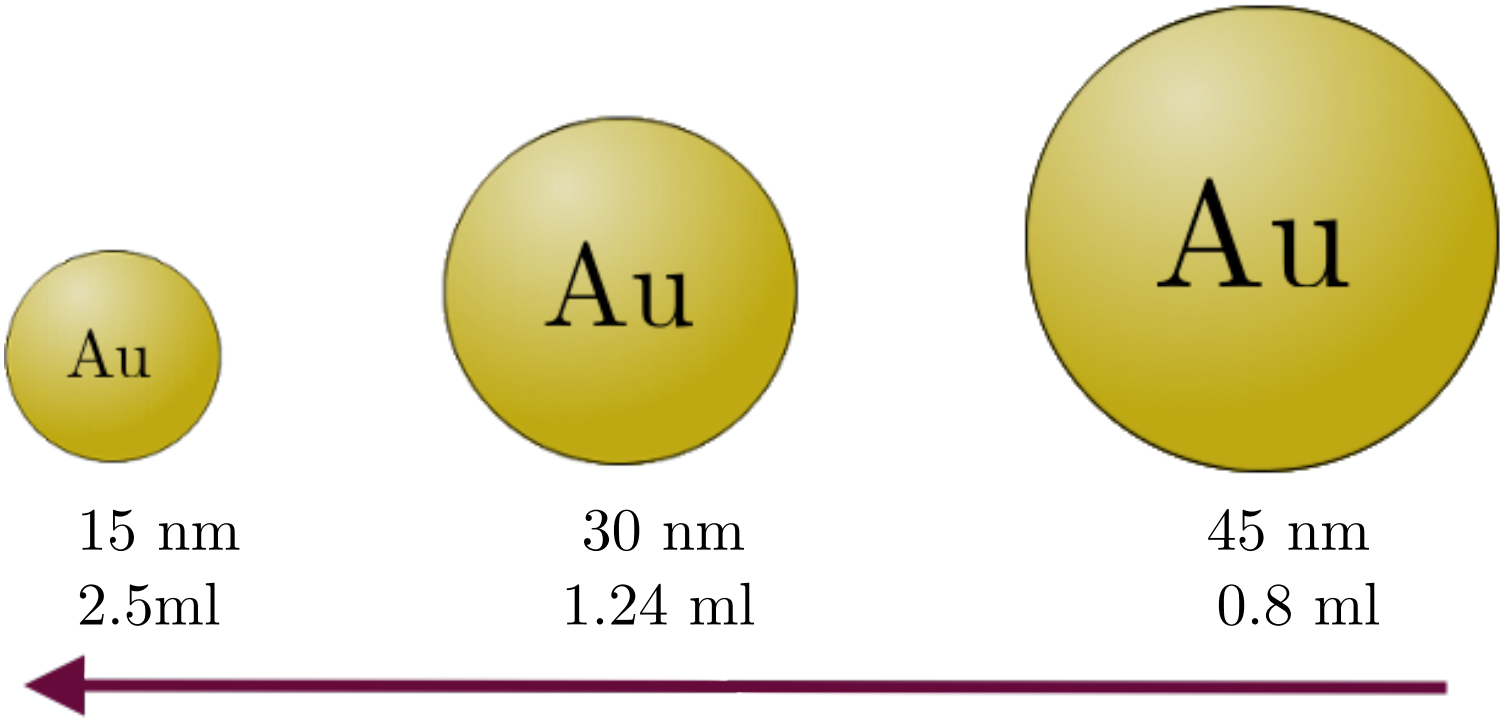
Gold ions: $HAuCl_4$ solution
Reducing agent: $Na_3C_6H_5O_7$

Reduction of gold ions to form GNP



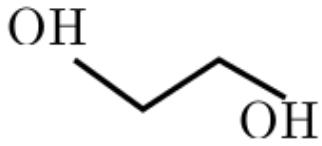
$$6Au^{3+} + C_6H_5O_7^{3-} + 15OH^- \rightarrow Au + 6CO_2 + 10H_2O$$

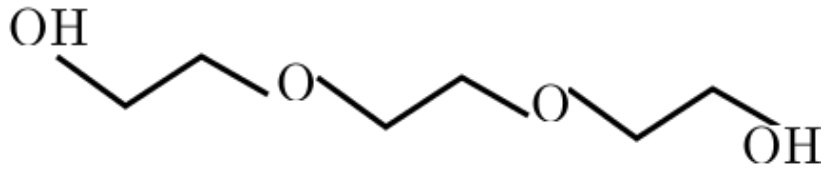
The amount of citrate controls the size



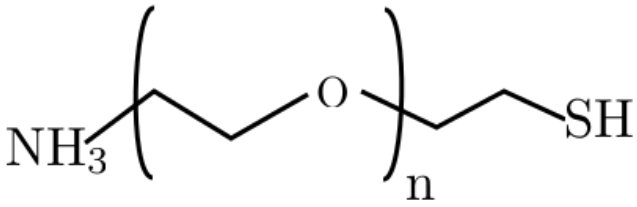
Citrate 1%
100ml $HAuCl_4$ 0.01%

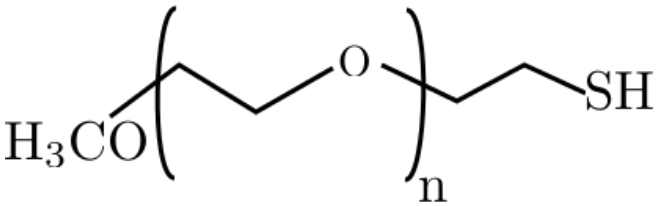
PEG for targeting and stabilization



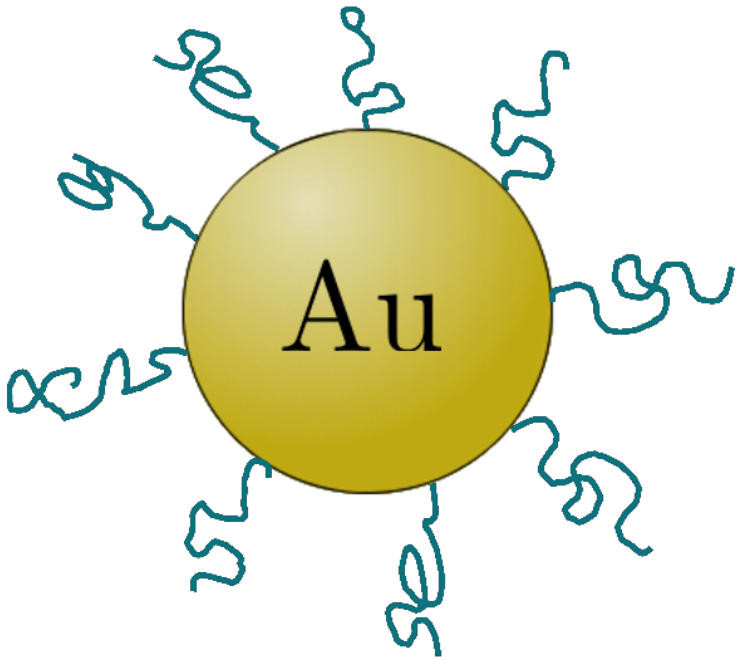


Ethylene glycol → Polyethylene glycol

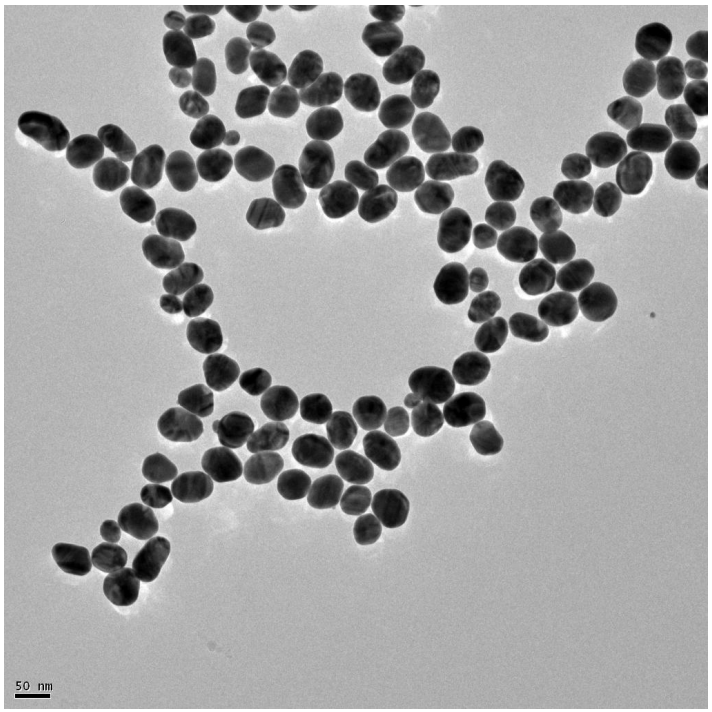


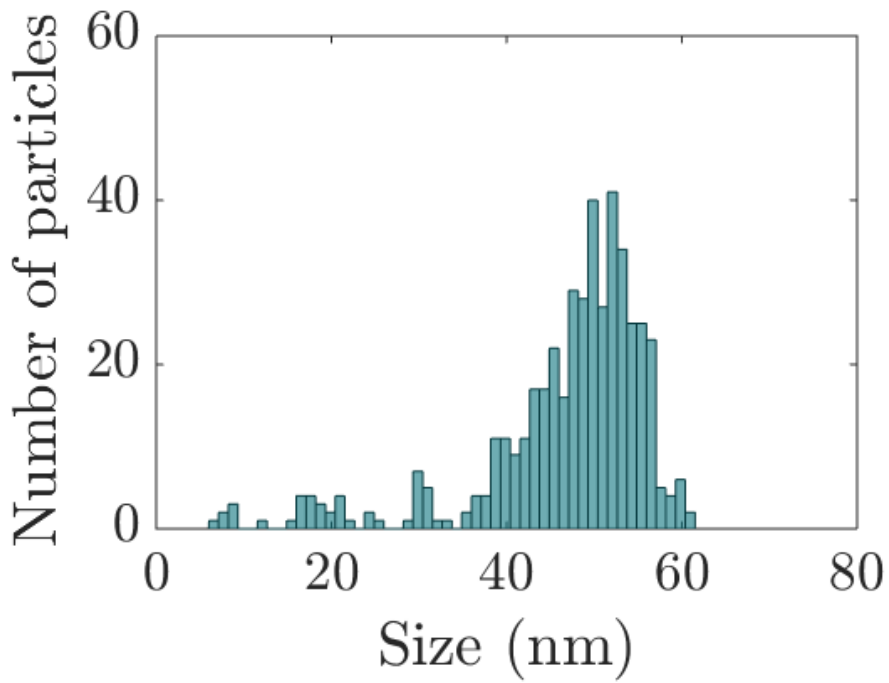


1k, 5k, 10k, 20k



TEM image analysis to determine the core diameter





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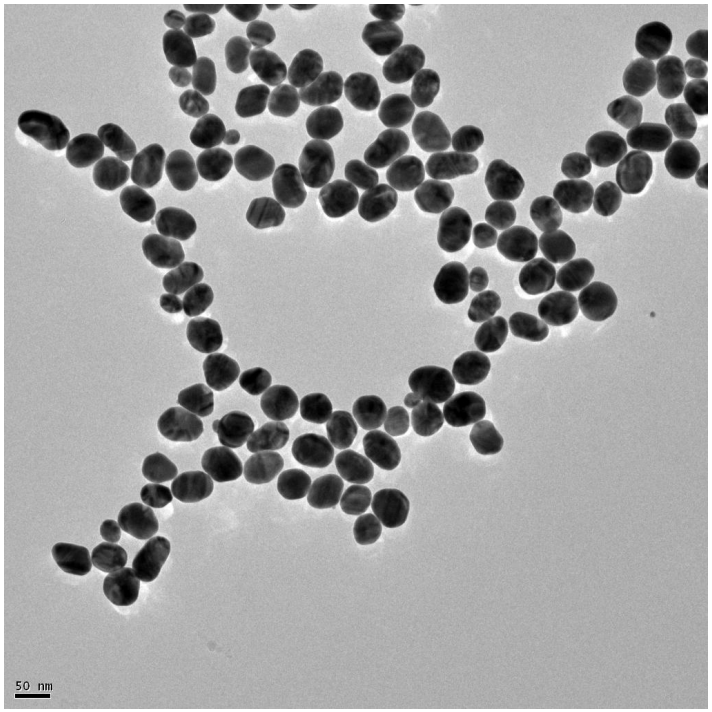
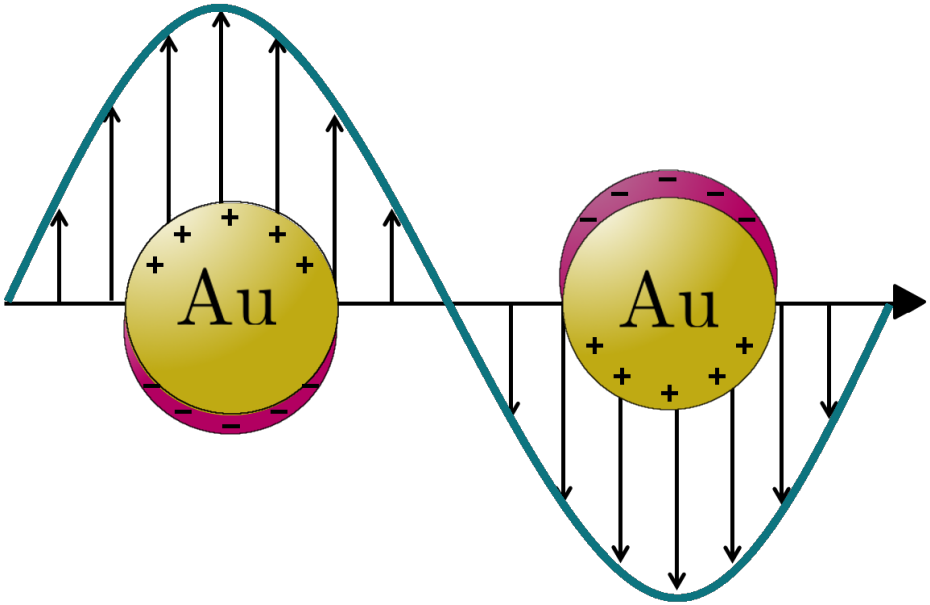
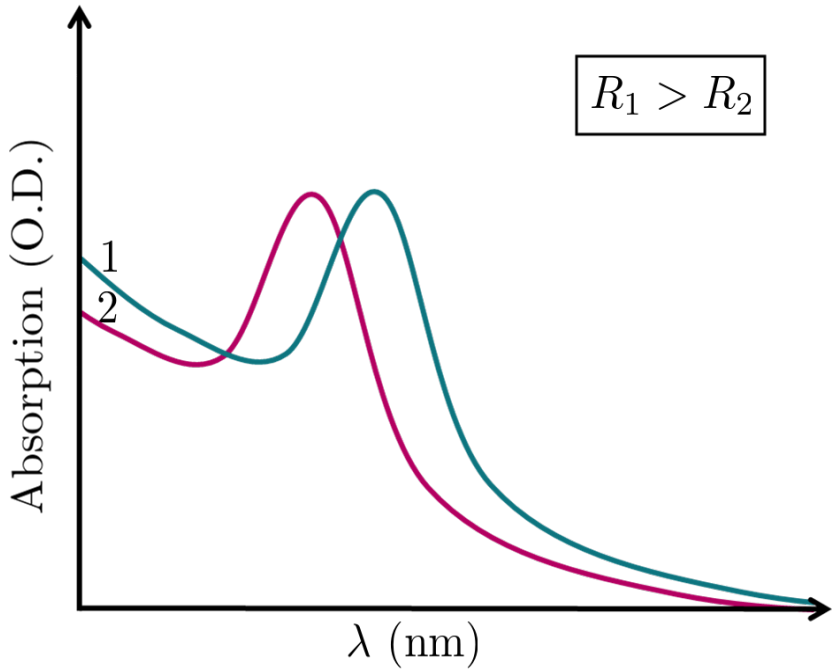


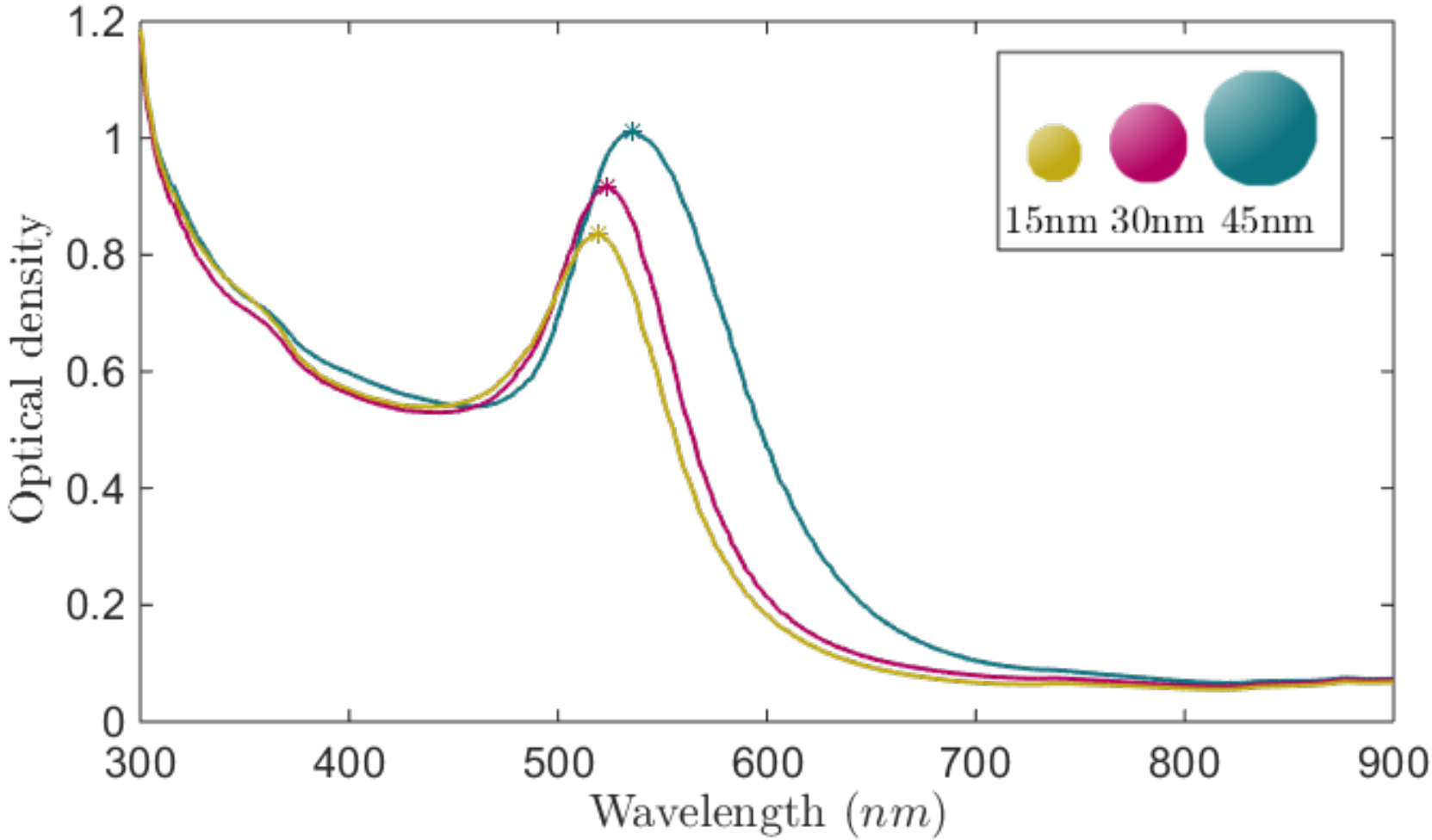
Exp. Size (nm)	Size (nm)
15	12.98 ± 0.23
	2.99 ± 0.16
30	18.29 ± 0.23
45	46.75 ± 0.47

Absorption measurements (UV-Vis) to determine the relative size



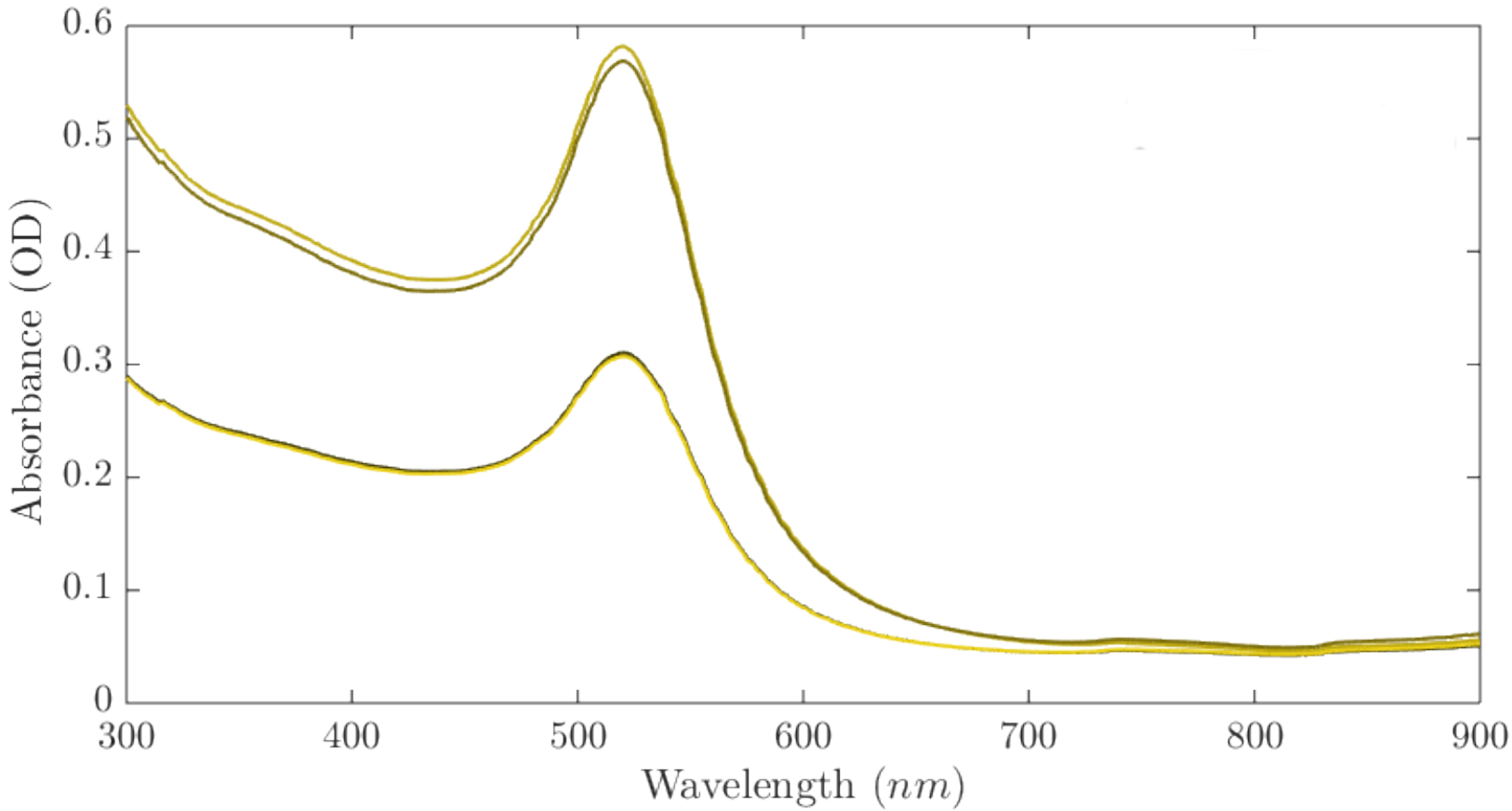


Absorption measurements (UV-Vis) to determine the relative size



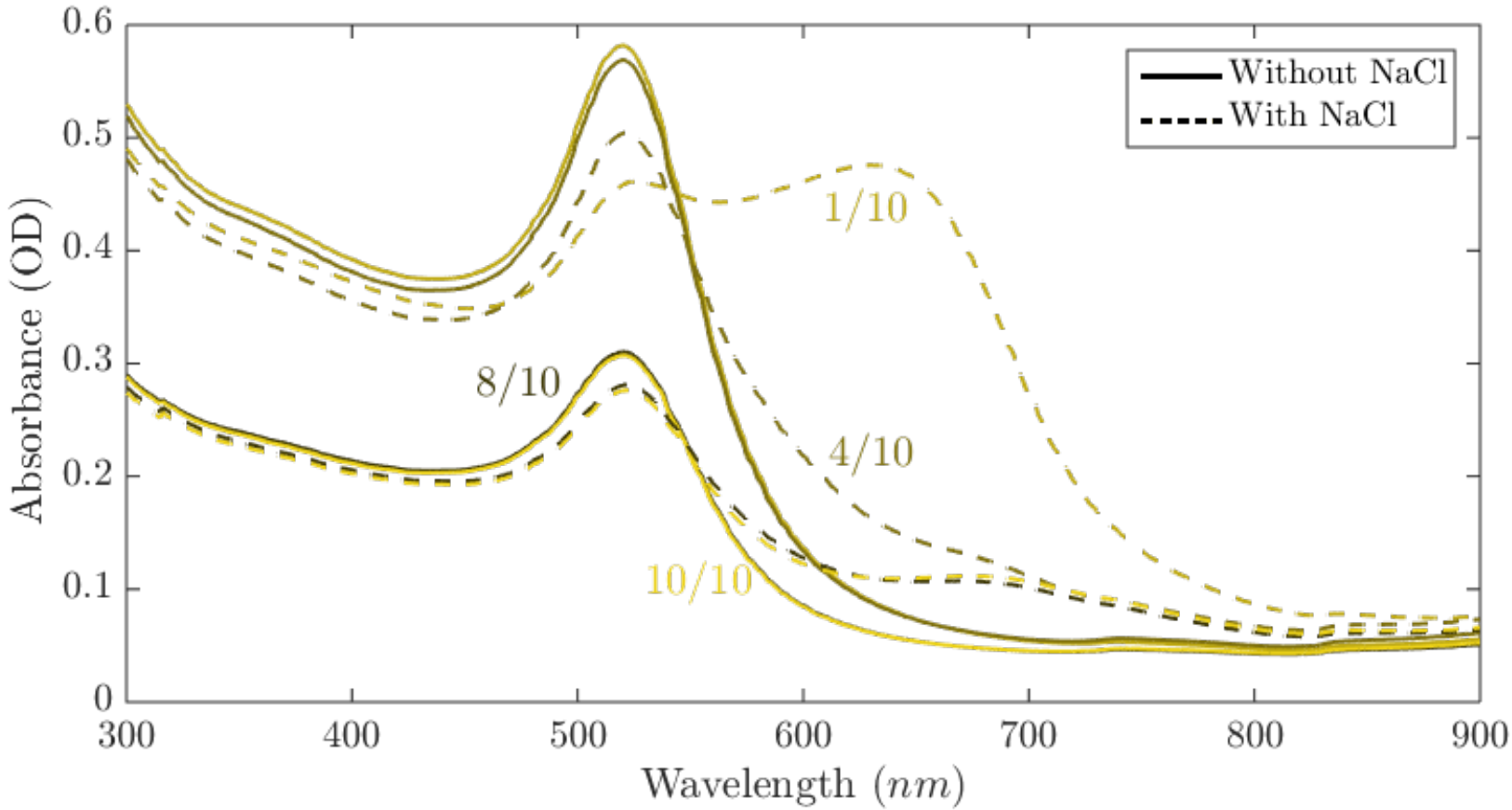
Absorption measurements (UV-Vis) to determine the optimal PEG proportion

1. Add PEG and preform UV-Vis measurement



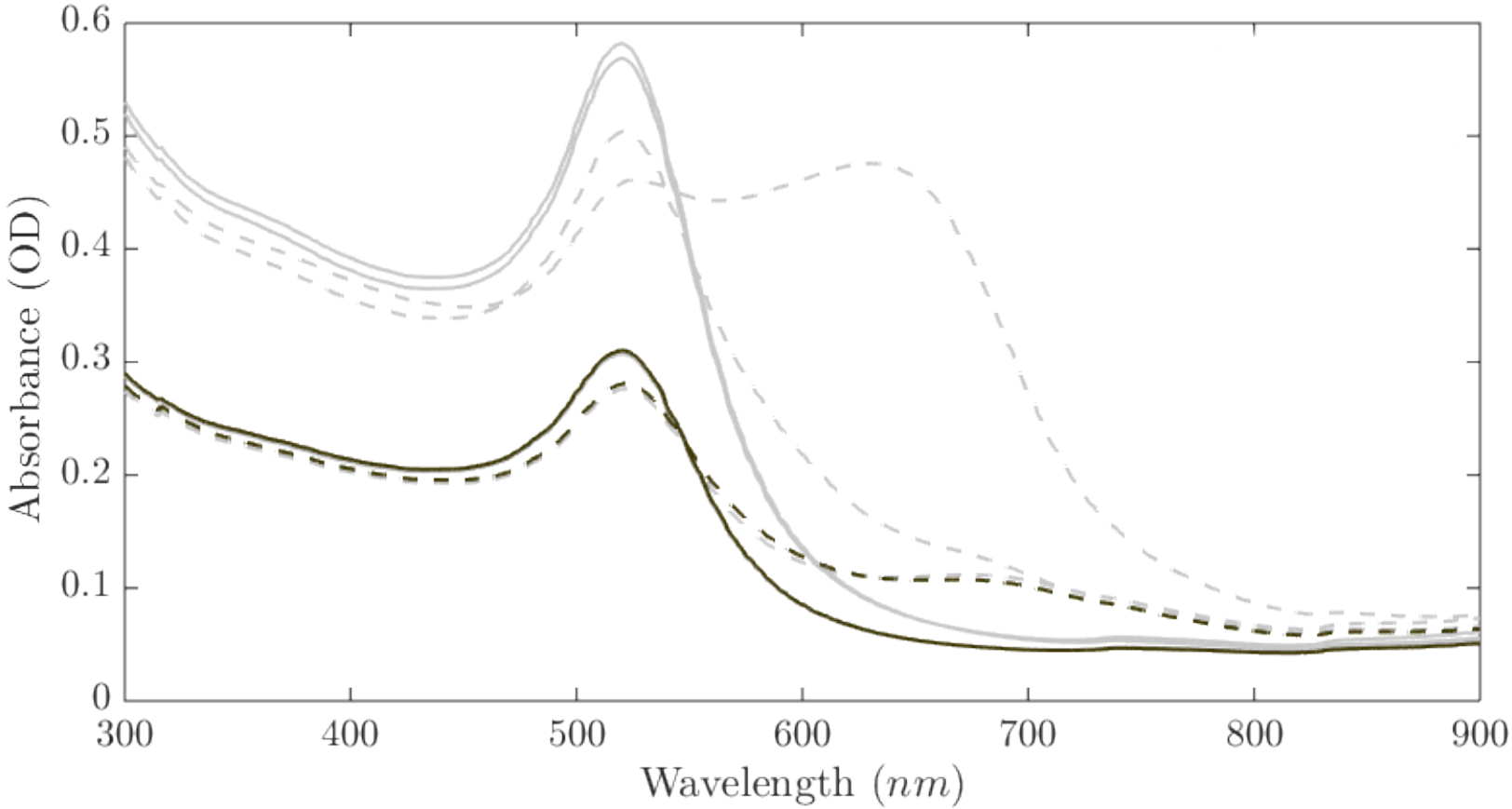
Absorption measurements (UV-Vis) to determine the optimal PEG proportion

2. Add NaCl and preform UV-Vis measurement



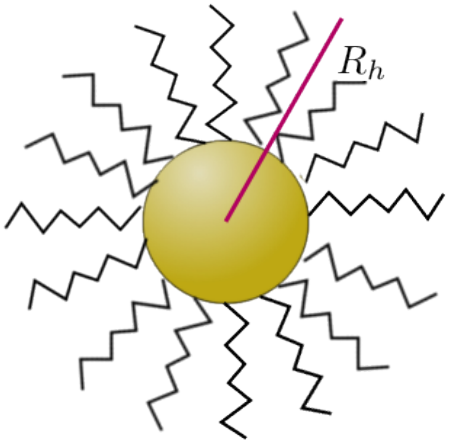
Absorption measurements (UV-Vis) to determine the optimal PEG proportion

bigger size → too little PEG
same size → enough PEG



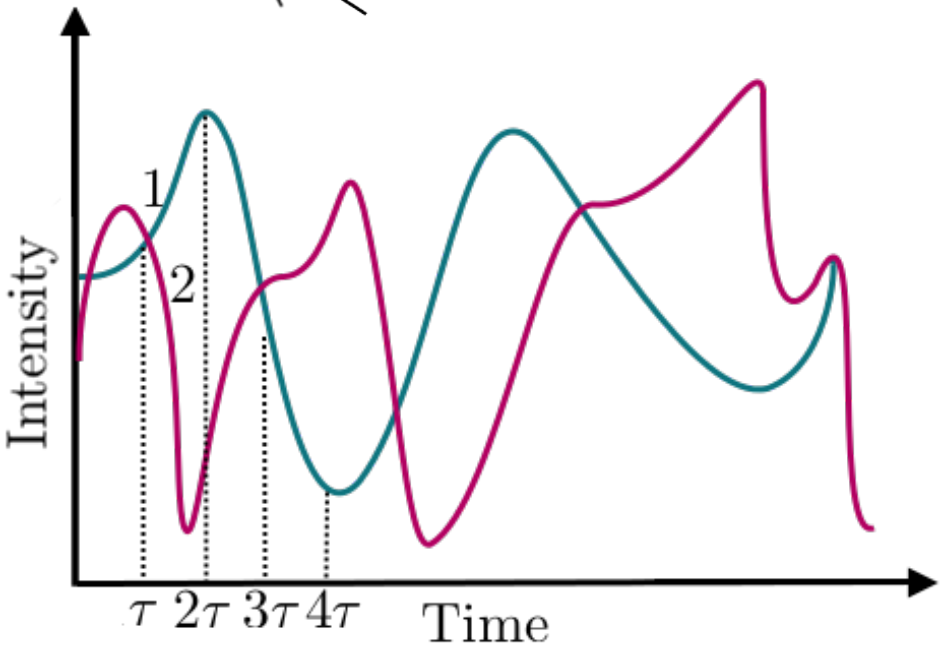
Light scattering experiments to determine the hydrodynamic radius (R_h)

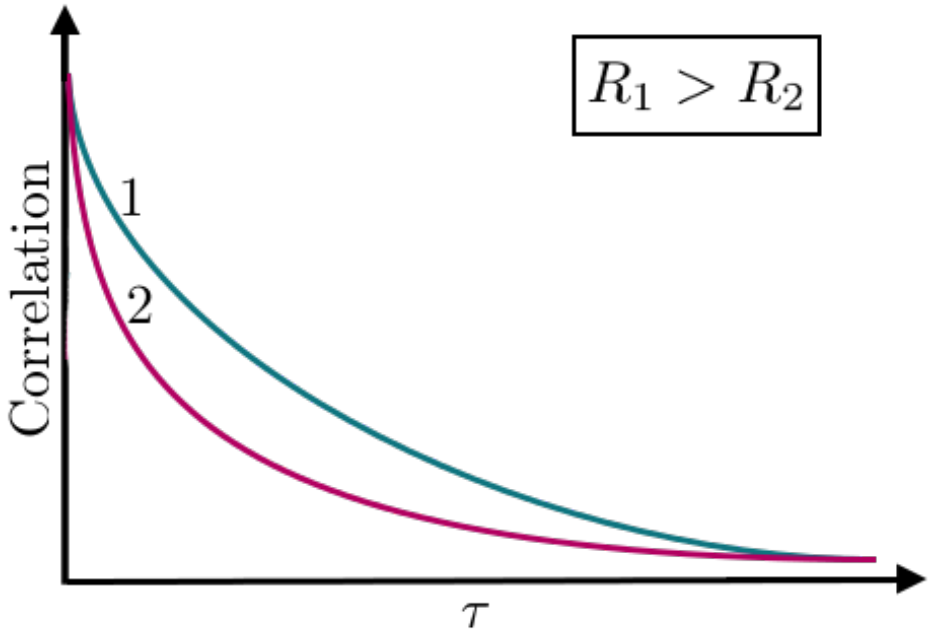
Important for diffusive properties



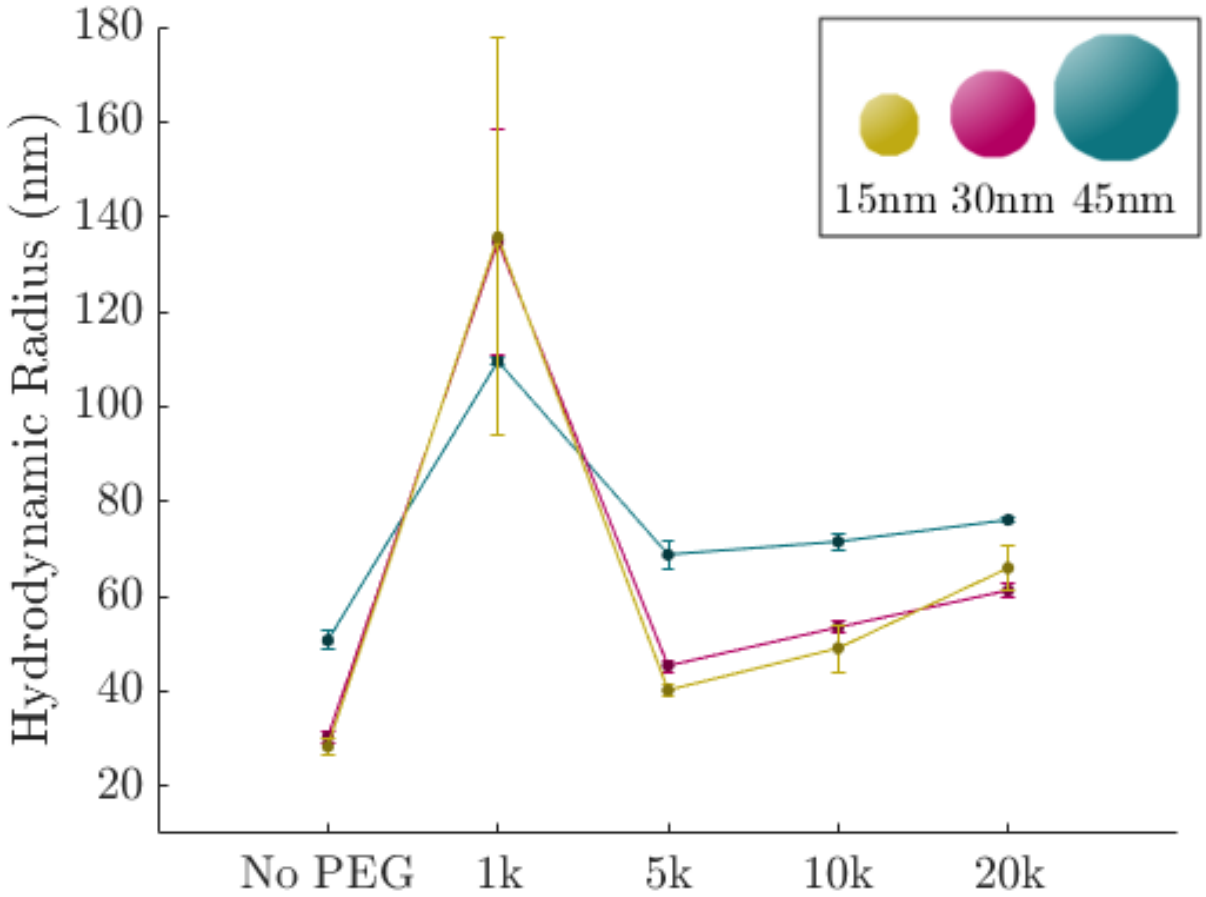
Correlation:

$$g(\tau) = \frac{\langle I(t)\rangle\langle I(t+\tau)\rangle}{\langle I(t)\rangle^2}$$





Hydrodynamic radii for the three different GNP with different functionalizations



Conclusion

- Synthesis of GNP
- Characterization
- Stabilization with neutral PEG
- Stabilization with positively charged PEG
- X-Rays
- Analyze effect on DNA
- Solve problem with DLS