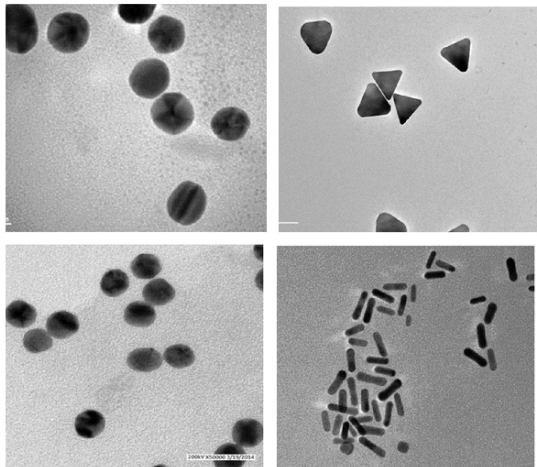
A scanning electron micrograph (SEM) showing several cells, likely cancer cells, with a rough, irregular surface. Numerous small, spherical gold nanoparticles are attached to the cell surfaces, particularly concentrated on the more irregular, protruding parts of the cells. The background is filled with many smaller, similar-looking particles.

Bachelor Thesis 2016
As. Bert De Roo, Matthias
Vervaele, Stephanie Seré

Radiosensitization using gold nanoparticles

25th March

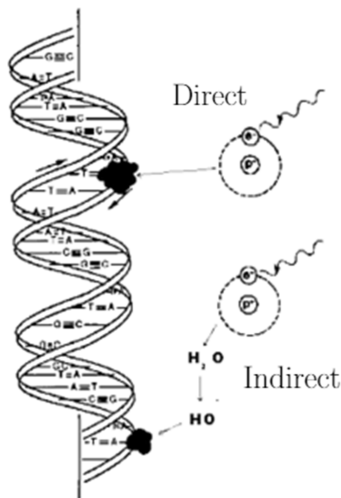
Introduction
Synthesis GNP
Chemical protocol
Size GNP
Stabilization
Characterization



Cancer treatment

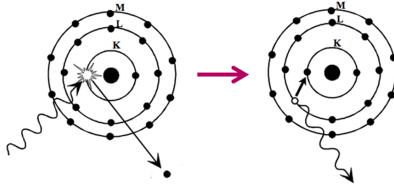
- Chemotherapy
- Surgery
- **Radiation therapy**

Energy $\sim MeV$

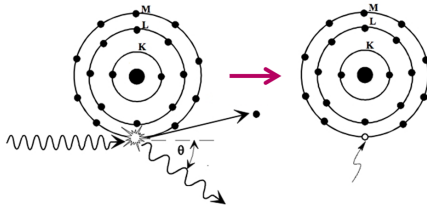


Radiosensitization with GNP $E \sim \text{keV}$

Photoelectric absorption



Compton effect

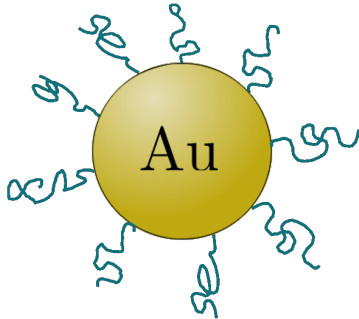


Why gold?

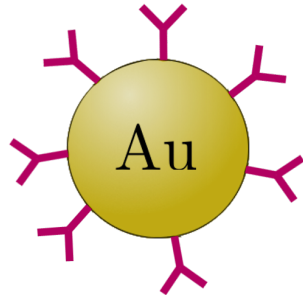
- High atomic number (79)
- Low toxicity

Targeting

Passive targeting
PEG coating

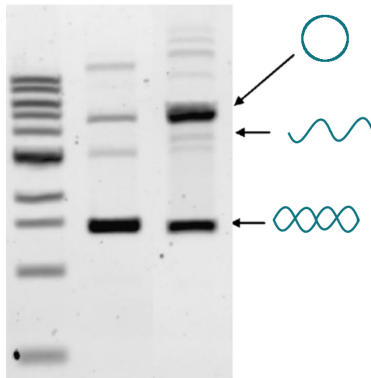


Active targeting
Antibodies



Goal

1. Synthesis
2. Characterization
3. Radiosensitization



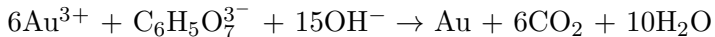
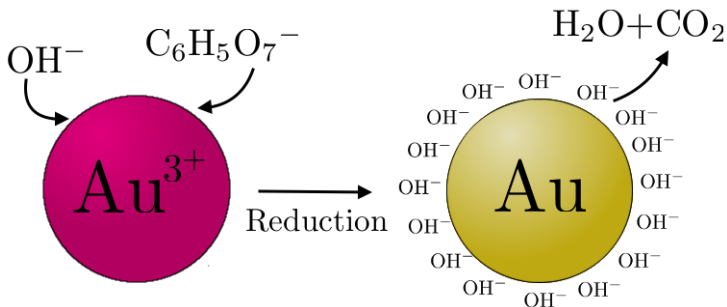
Chemical protocol



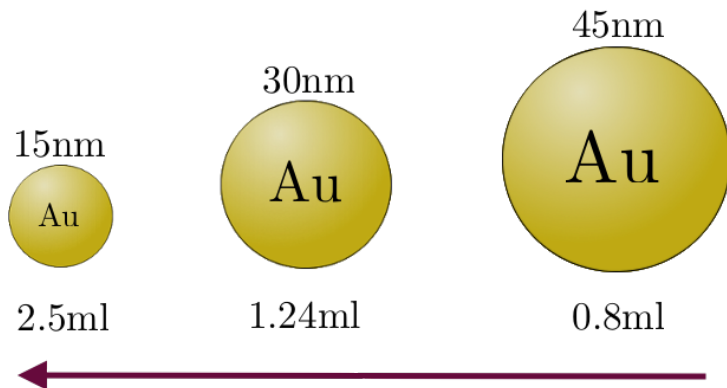
Gold ions: HAuCl_4 solution

Reducing agent: $\text{Na}_3\text{C}_6\text{H}_5\text{O}_7$

Chemical protocol



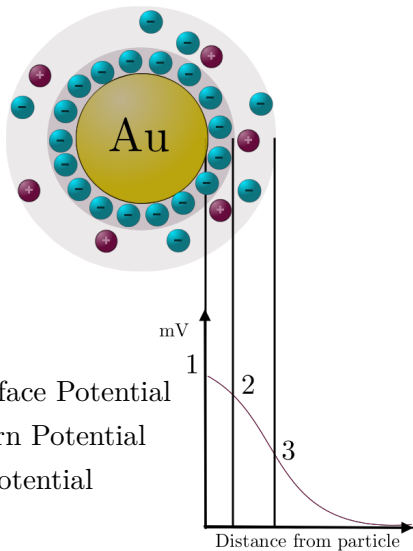
Size GNP



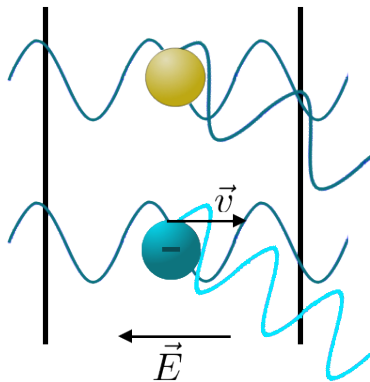
Citrate 1%

100ml HAuCl₄ 0.01%

Zeta Potential

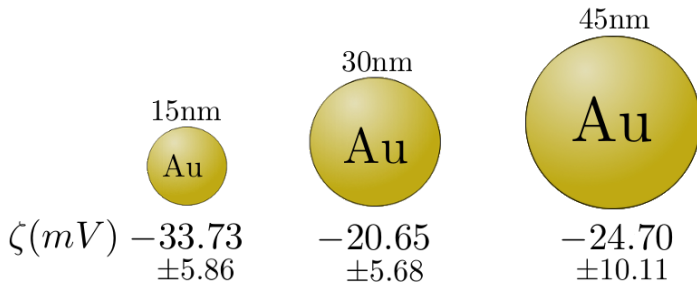


Laser Doppler Gel electrophoresis

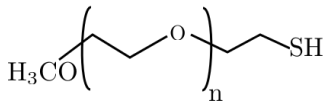
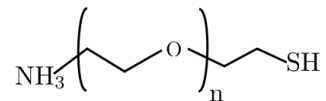
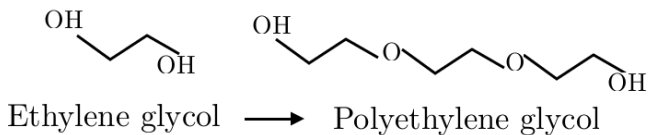


$$\zeta = \frac{2\eta v}{3E\epsilon} \quad |\zeta| \geq 30\text{mV}$$

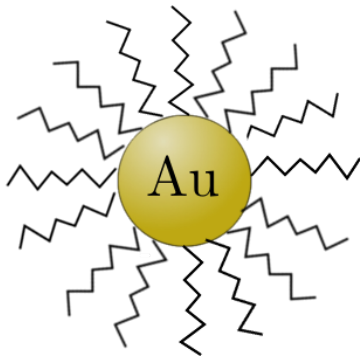
Zeta Potential: Results



Functionalization PEG

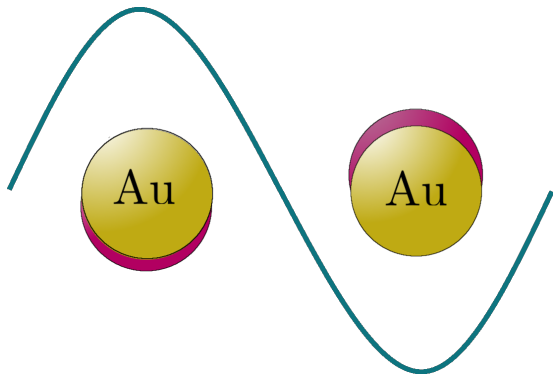


20k, 10k, 5k, 1k



UV-Vis spectroscopy

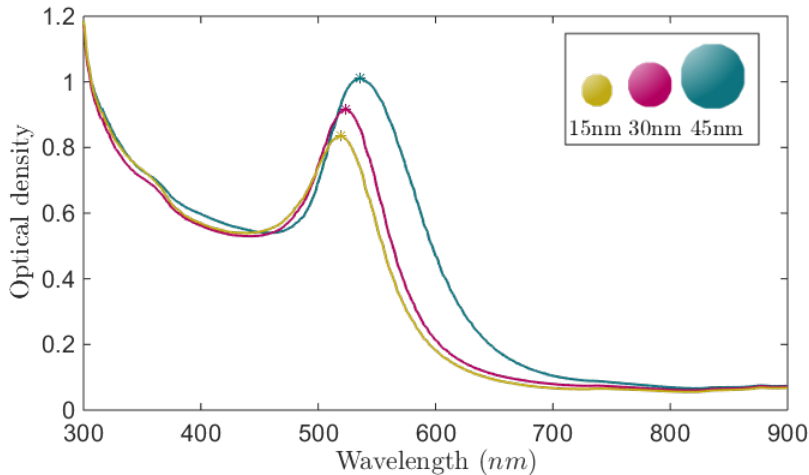
1. Add PEG
2. Size GNP
3. Add NaCl
4. Size GNP



bigger size \rightarrow too little PEG
same size \rightarrow enough PEG

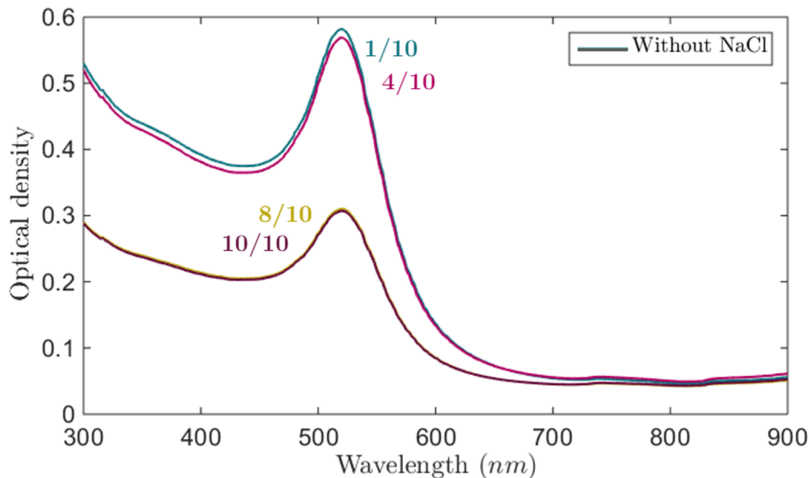
Results

GNP no PEG



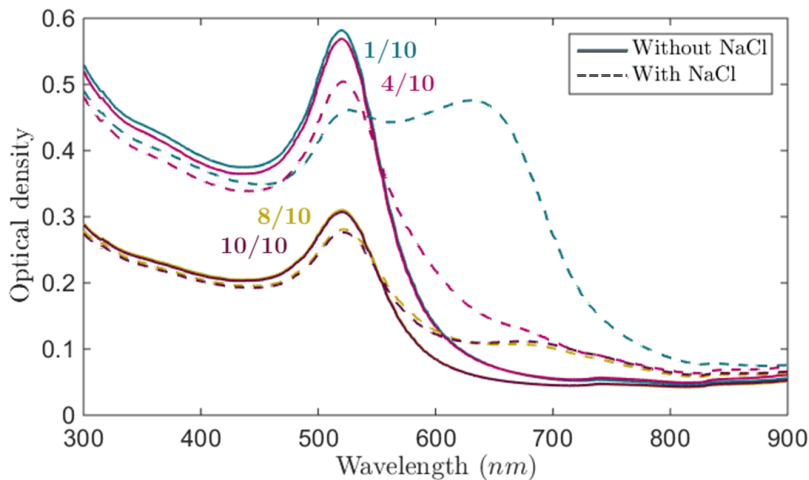
Results

15nm GNP 20k PEG for different PEG/GNP



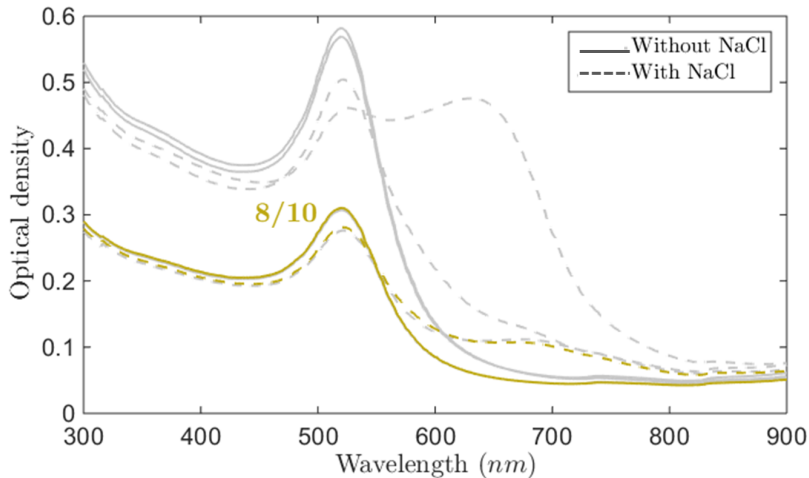
Results

15nm GNP 20k PEG for different PEG/GNP



Results

15nm GNP 20k PEG for different PEG/GNP



Overview

Introduction

Synthesis GNP

Chemical Protocol

Size GNP

Stabilization

Characterization

Size GNP

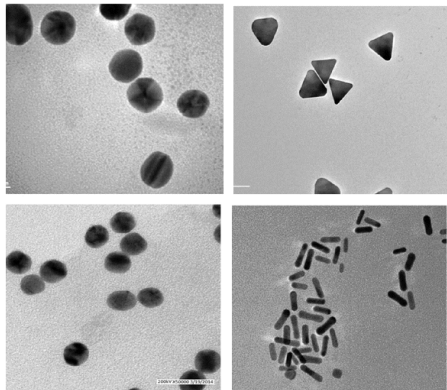
Chemical Protocol

UV-VIS

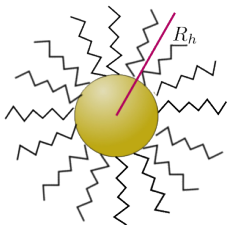
TEM

Hydrodynamic Radius

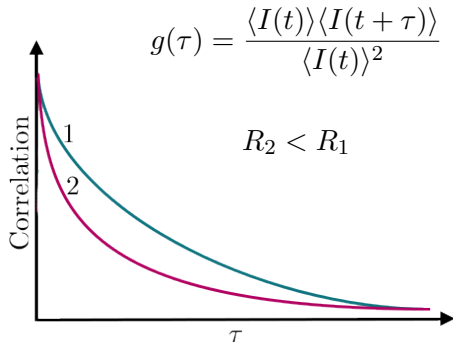
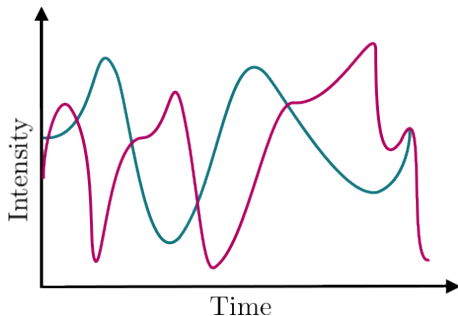
DLS



Dynamic light scattering (DLS)



Hydrodynamic radius (R_h)
 → Rayleigh scattering

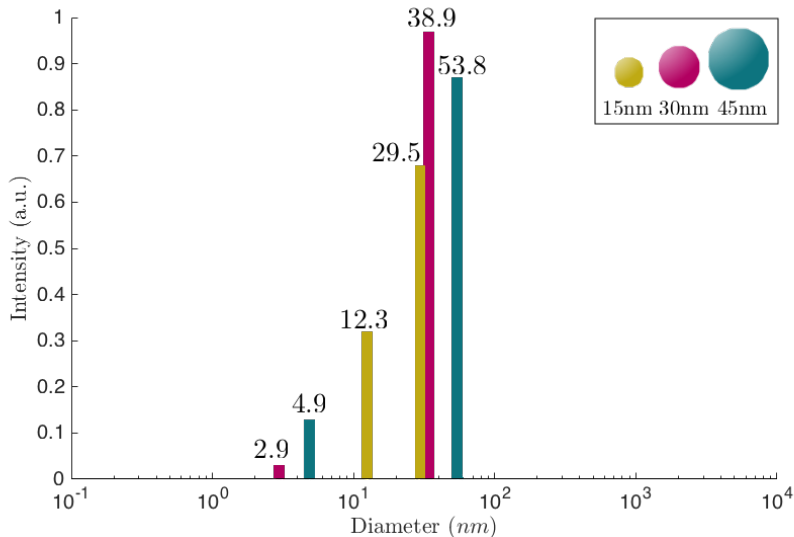


$$g(\tau) = \frac{\langle I(t) \rangle \langle I(t + \tau) \rangle}{\langle I(t) \rangle^2}$$

$$R_2 < R_1$$

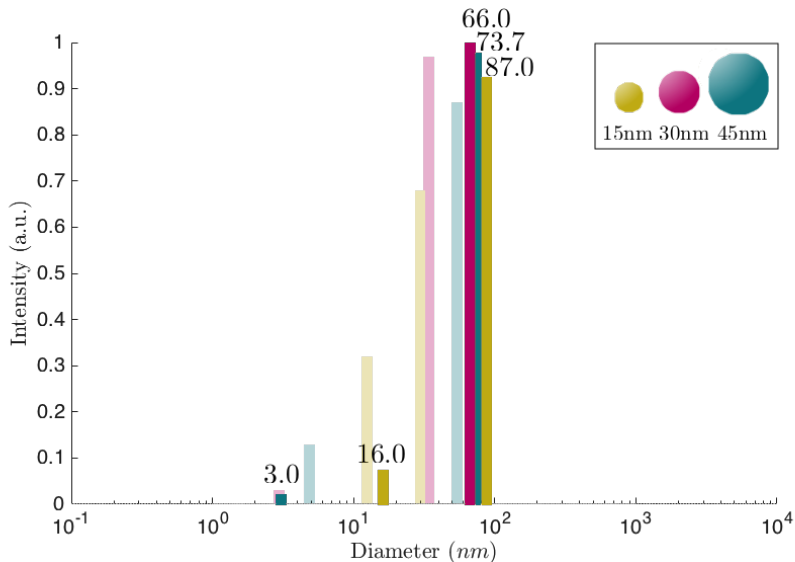
Results

Functionalisation no PEG



Results

Functionalisation 20k PEG

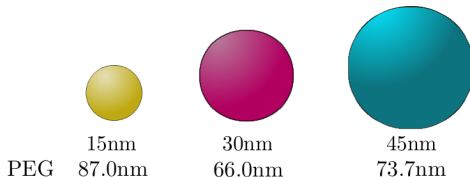


Results

Functionalization 15nm 20k PEG

Proportion (PEG/GNP)	Average
5/10	51.93 ± 2.76
6/10	80.89 ± 14.64
7/10	65.24 ± 14.32
8/10	83.91 ± 18.42
9/10	

Original functionalization 20k (8/10)

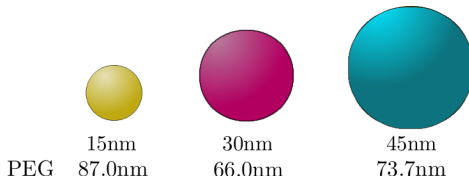


Results

Functionalization 15nm 20k PEG

Proportion (PEG/GNP)	Average	Average (centrifuge)
5/10	51.93 ± 2.76	68.70 ± 7.99
6/10	80.89 ± 14.64	65.16 ± 11.61
7/10	65.24 ± 14.32	57.73 ± 7.72
8/10	83.91 ± 18.42	72.36 ± 10.44
9/10		56.54 ± 3.91

Original functionalization 20k (8/10)



Conclusion

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

