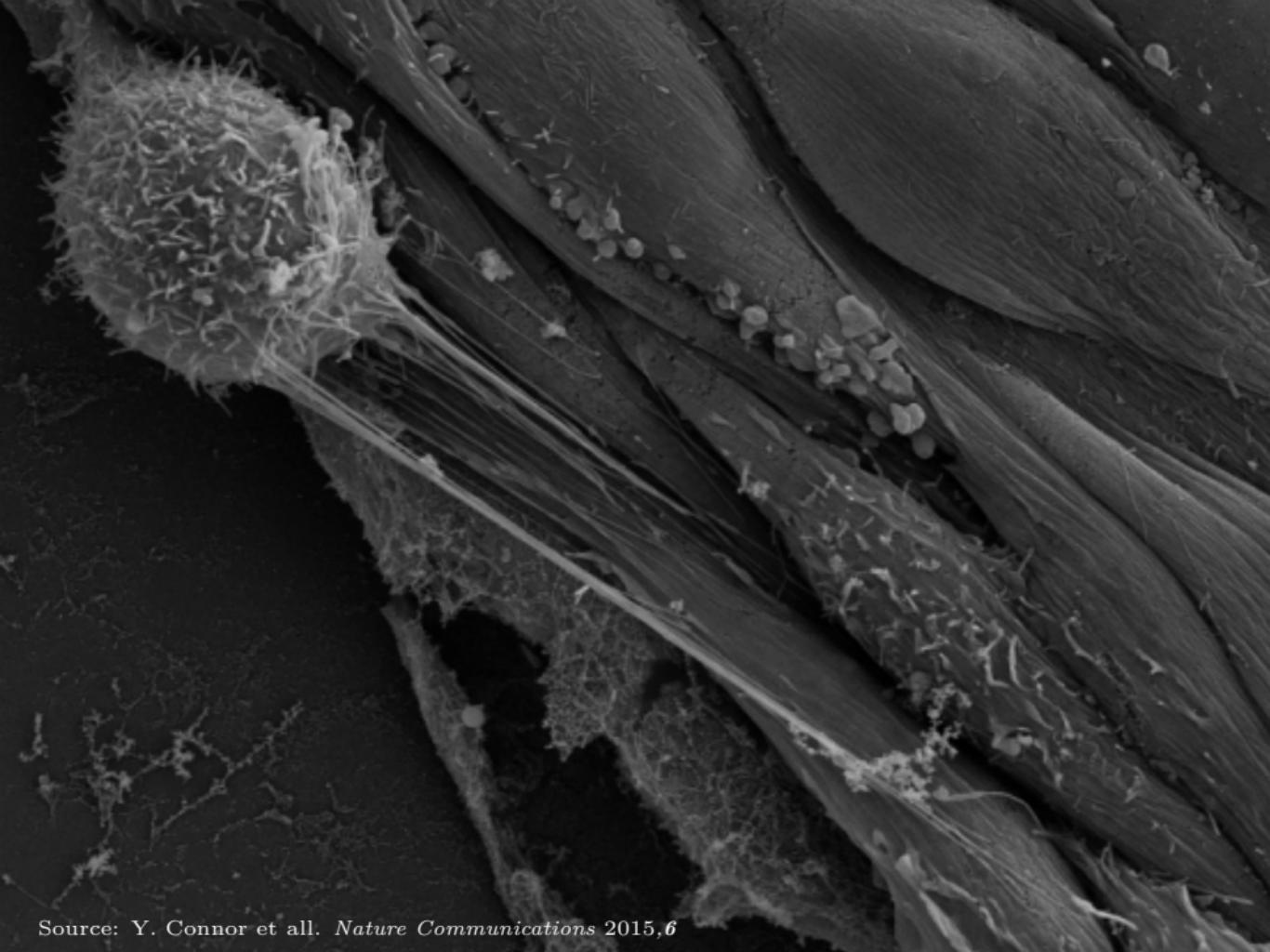


Bachelor Thesis 2016

# Radiosensitization using gold nanoparticles

Lies Deceuninck and Hannelore Verhoeven

Supervisors: Bert De Roo  
                  Mattias Vervaele  
Professor:     Jean-Pierre Locquet

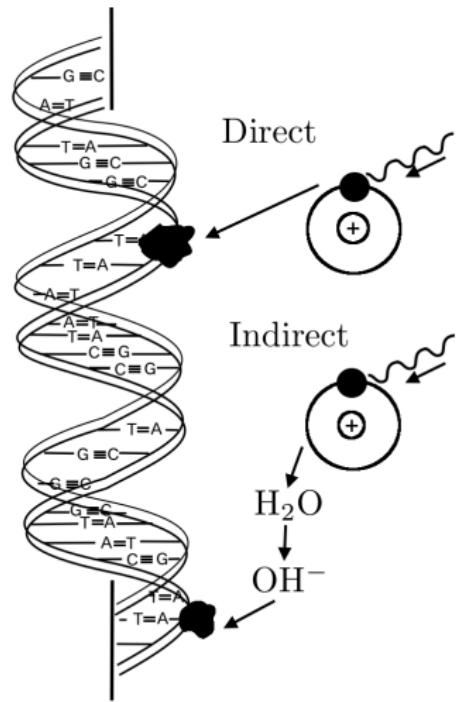


Source: Y. Connor et all. *Nature Communications* 2015, **6**

# DNA damage using ionizing radiation

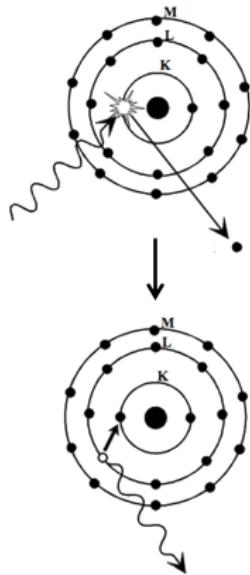
- Chemotherapy
- Surgery
- **Radiation therapy**

Energy  $\sim$  MeV

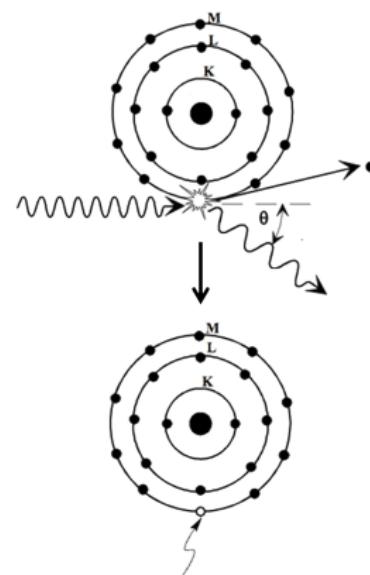


# Radiosensitization of cancer cells with gold nanoparticles (GNP) $E \sim \text{keV}$

Photoelectric absorption



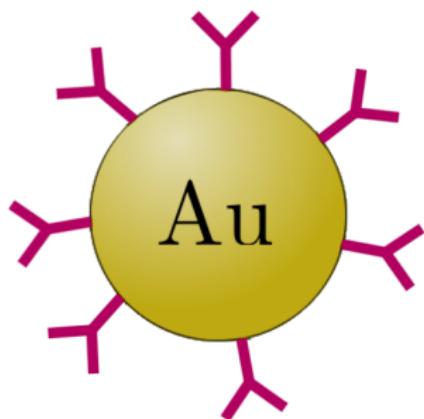
Compton effect



# Targeting of the GNP to the tumor

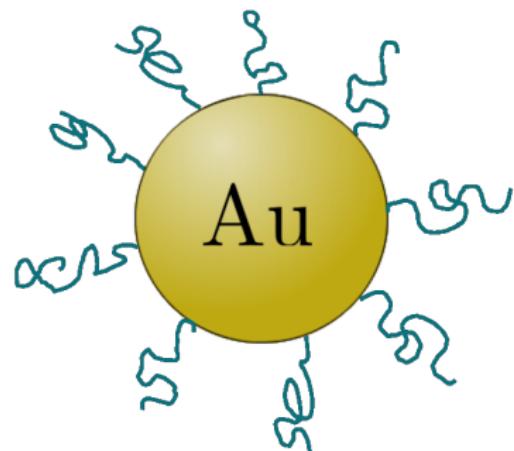
## Active targeting

Antibodies



## Passive targeting

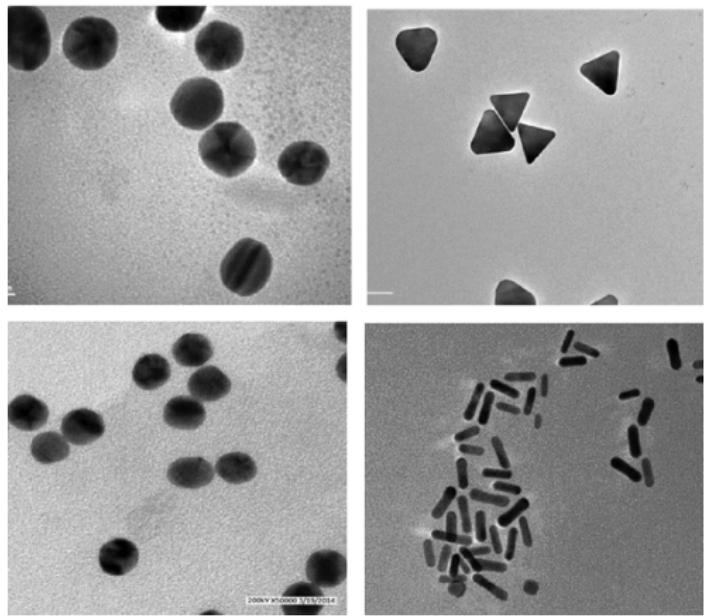
PEG coating



# Overview Project

## Radiosensitization of DNA using gold nanoparticles

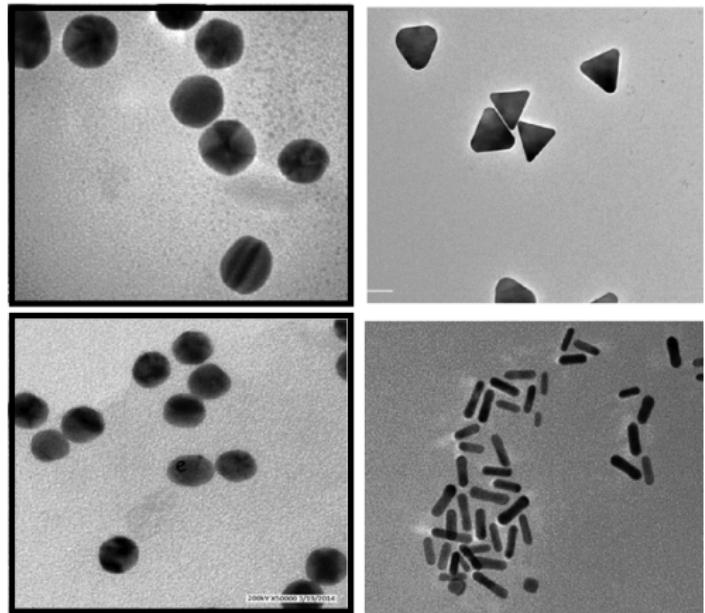
1. Synthesis
2. Characterization
  - a. TEM
  - b. UV-Vis
  - c. DLS
3. Radiosensitization



# Overview Project

## Radiosensitization of DNA using gold nanoparticles

1. Synthesis
2. Characterization
  - a. TEM
  - b. UV-Vis
  - c. DLS
3. Radiosensitization



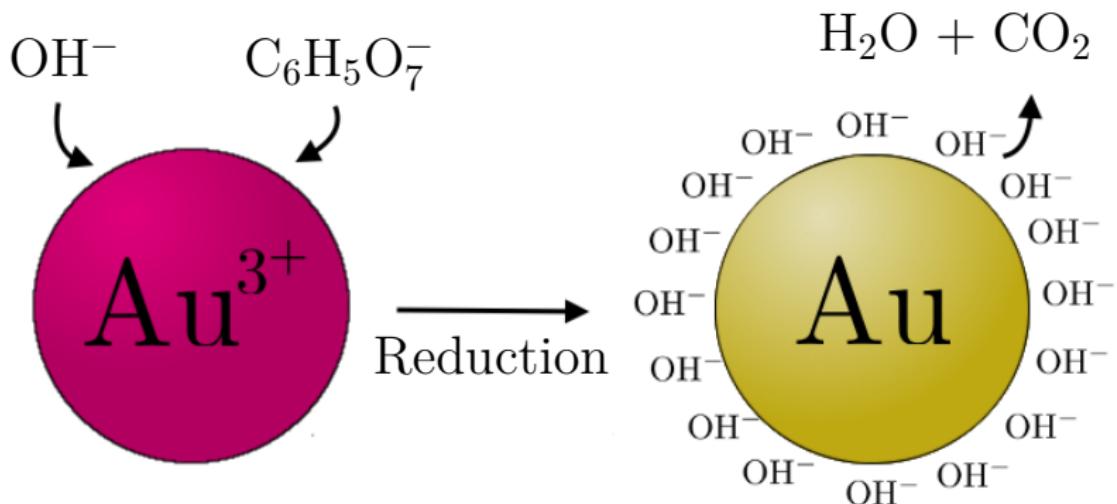
# Reduction of gold ions to form GNP



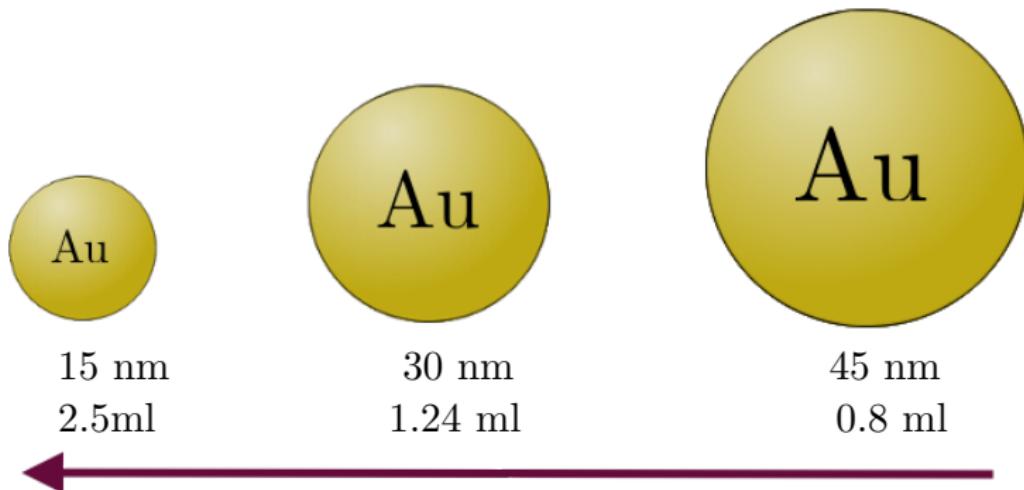
Gold ions: HAuCl<sub>4</sub> solution

Reducing agent: Na<sub>3</sub>C<sub>6</sub>H<sub>5</sub>O<sub>7</sub>

# Reduction of gold ions to form GNP

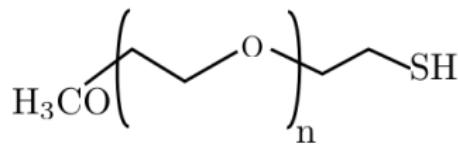
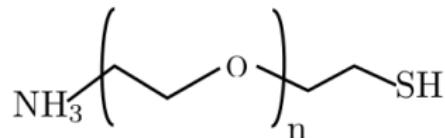
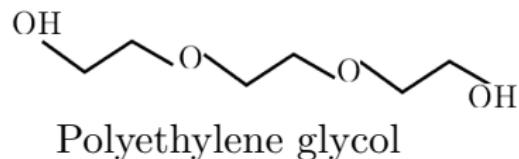


The amount of citrate controls the size

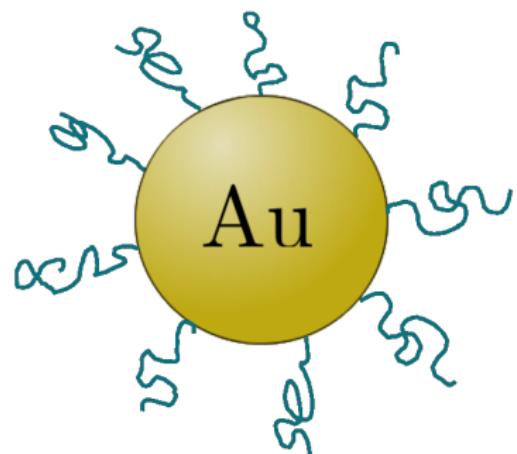


Citrate 1%  
100ml HAuCl<sub>4</sub> 0.01%

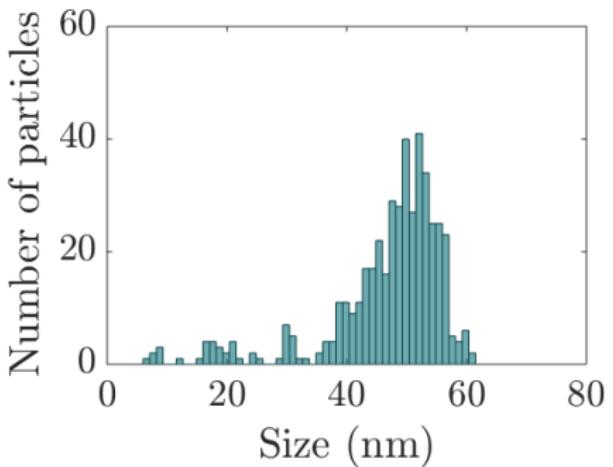
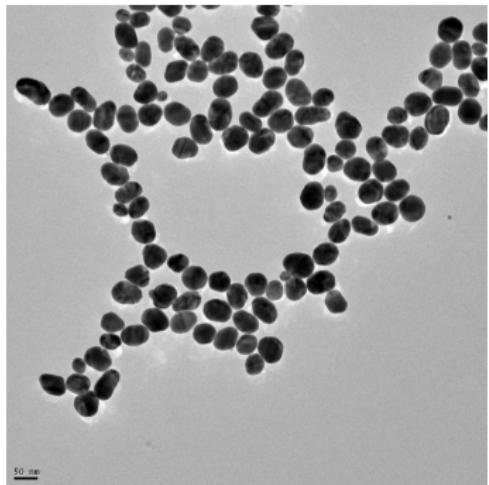
# PEG for targeting and stabilization



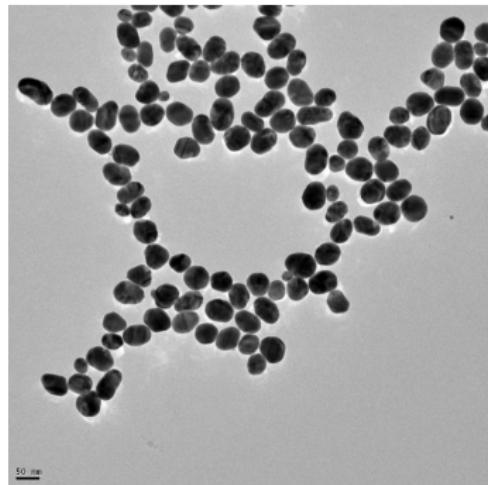
1k, 5k, 10k, 20k



# TEM image analysis to determine the core diameter

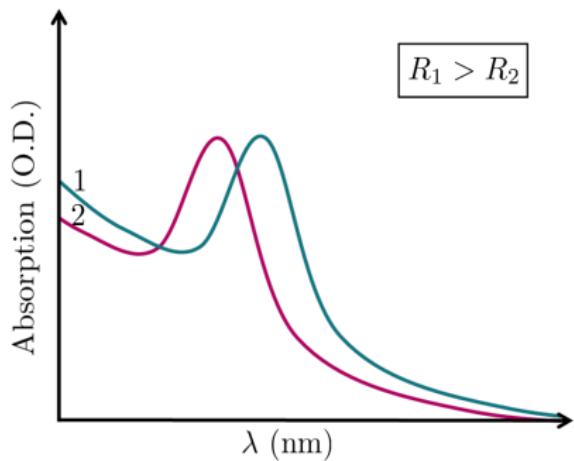
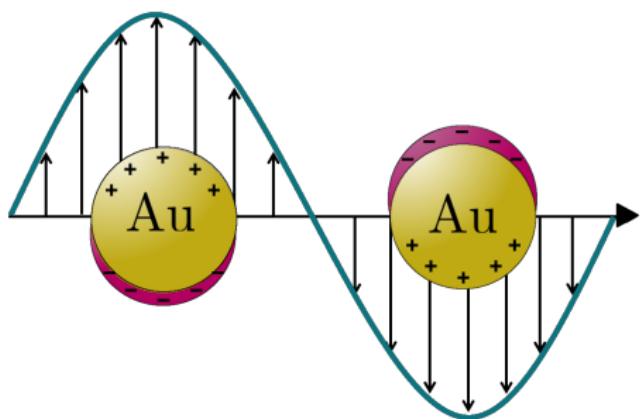


# TEM image analysis to determine the core diameter



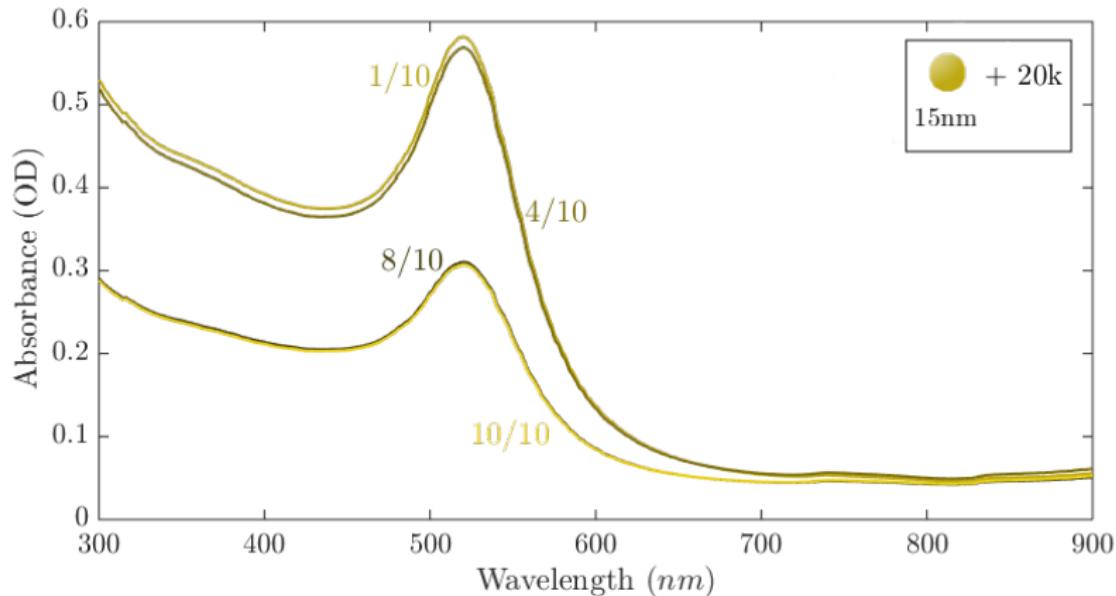
Exp. Size (nm)	Size (nm)
15	$12.98 \pm 0.23$
	$2.99 \pm 0.16$
30	$18.29 \pm 0.23$
45	$46.75 \pm 0.47$

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



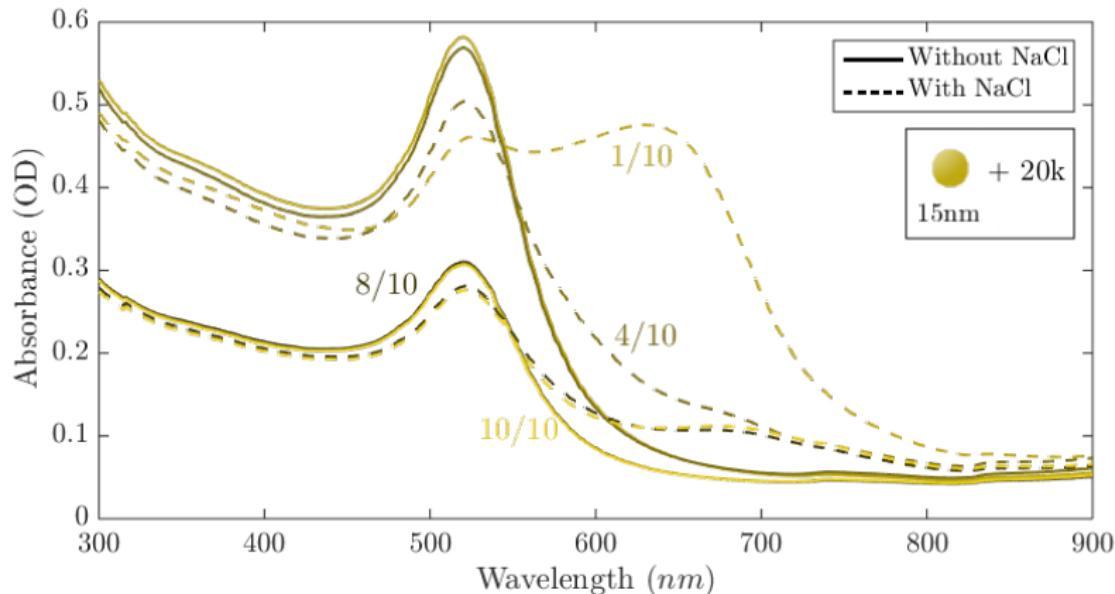
# Find optimal PEG/GNP proportion

1. Add PEG and perform UV-Vis measurement

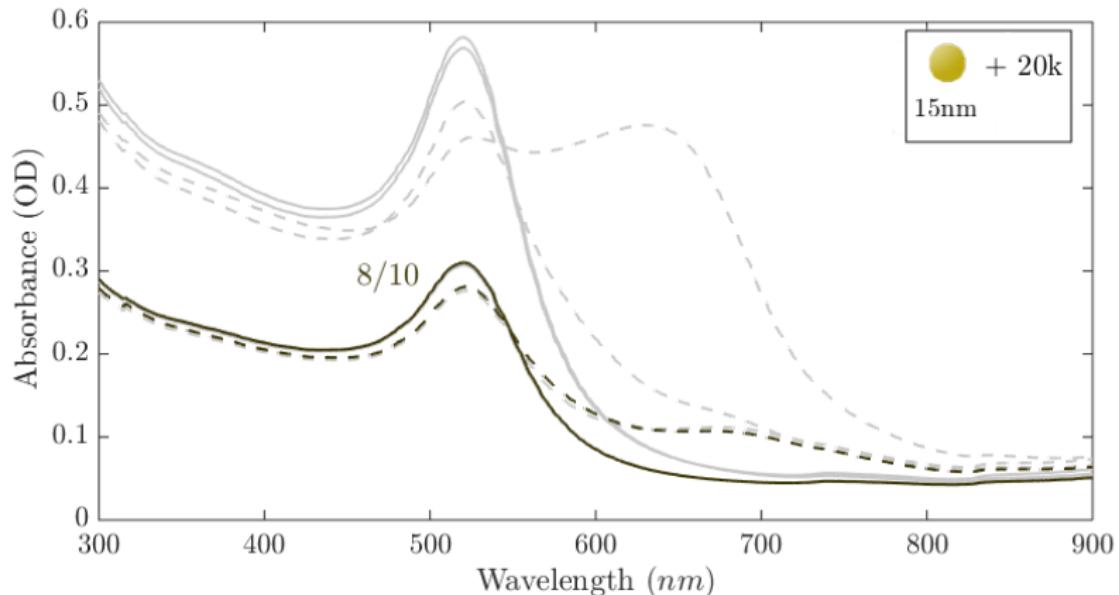


# Find optimal PEG/GNP proportion

2. Add NaCl and perform UV-Vis measurement

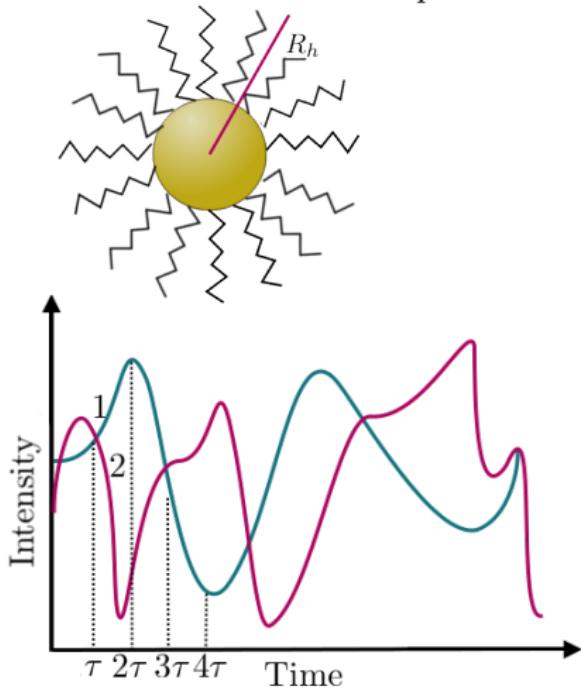


# Find optimal PEG/GNP proportion



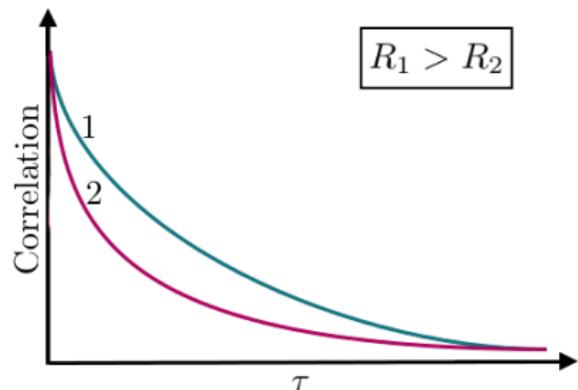
# Light scattering experiments to determine the hydrodynamic radius ( $R_h$ )

Important for diffusive properties

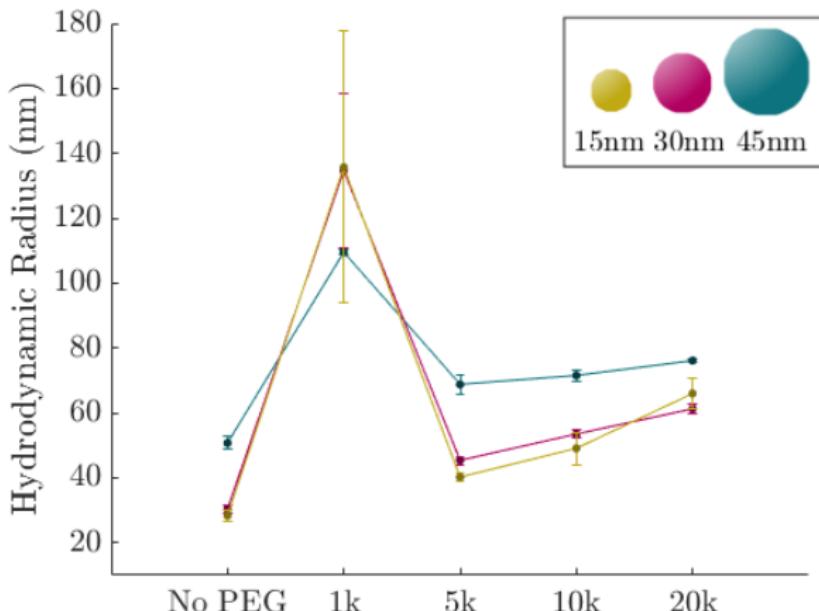


Correlation:

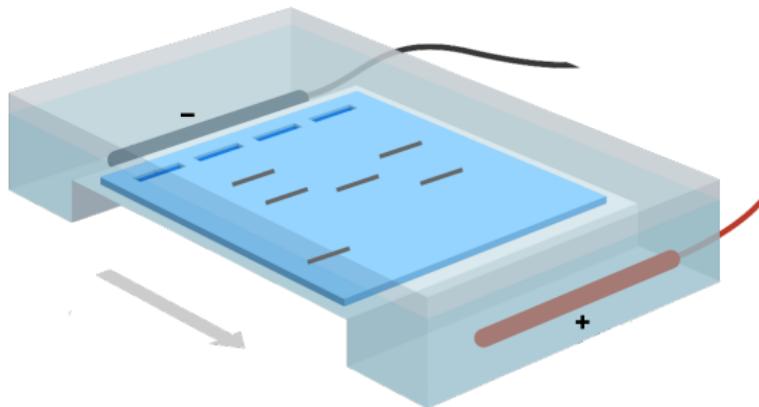
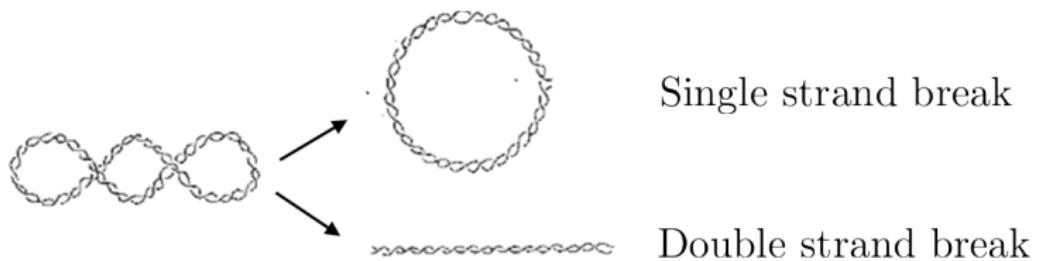
$$g(\tau) = \frac{\langle I(t) \rangle \langle I(t+\tau) \rangle}{\langle I(t) \rangle^2}$$



# Hydrodynamic radii for the three different GNP with different functionalizations

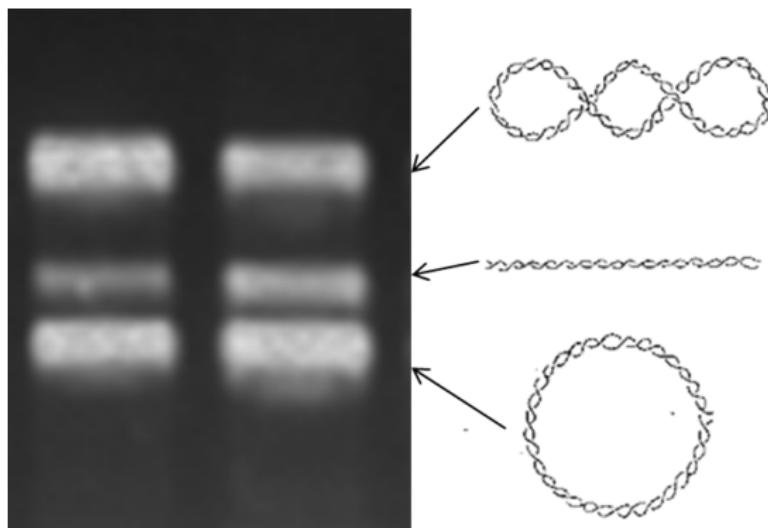


# Gel electrophoresis to analyse DNA damage

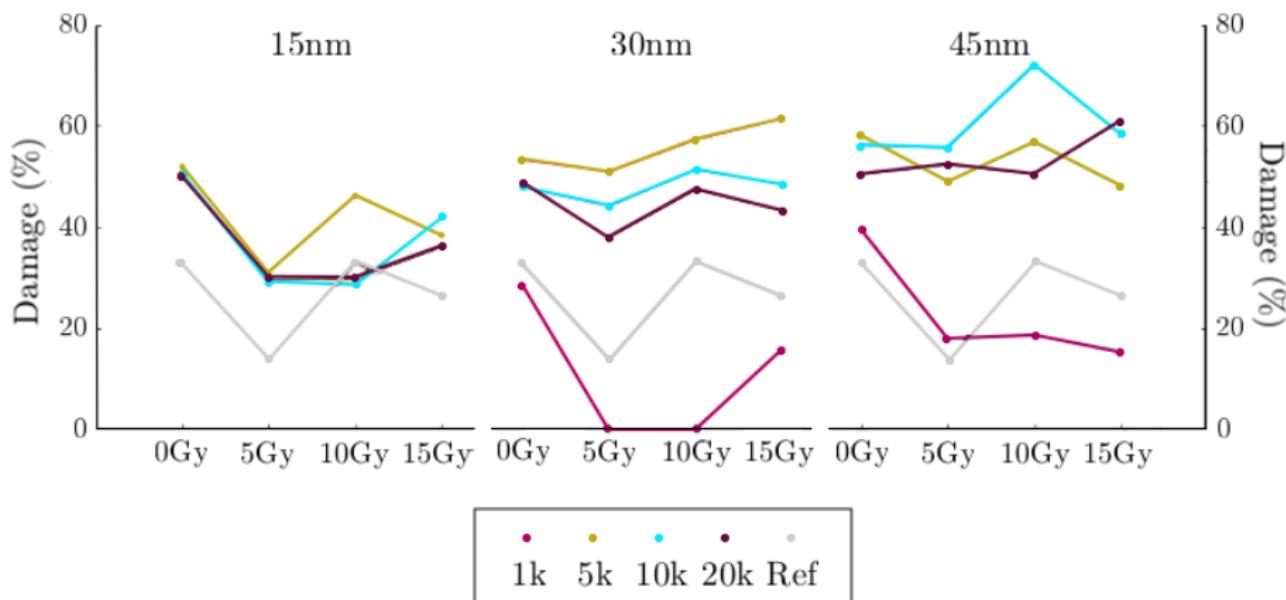


Sources: <https://www.quora.com/Whats-the-difference-between-a-plasmid-and-a-virus>.  
<http://www.vce.bioninja.com.au/aos-3-heredity/molecular-biology-technique/dna-profiling.html>

# Gel electrophoresis to analyse DNA damage

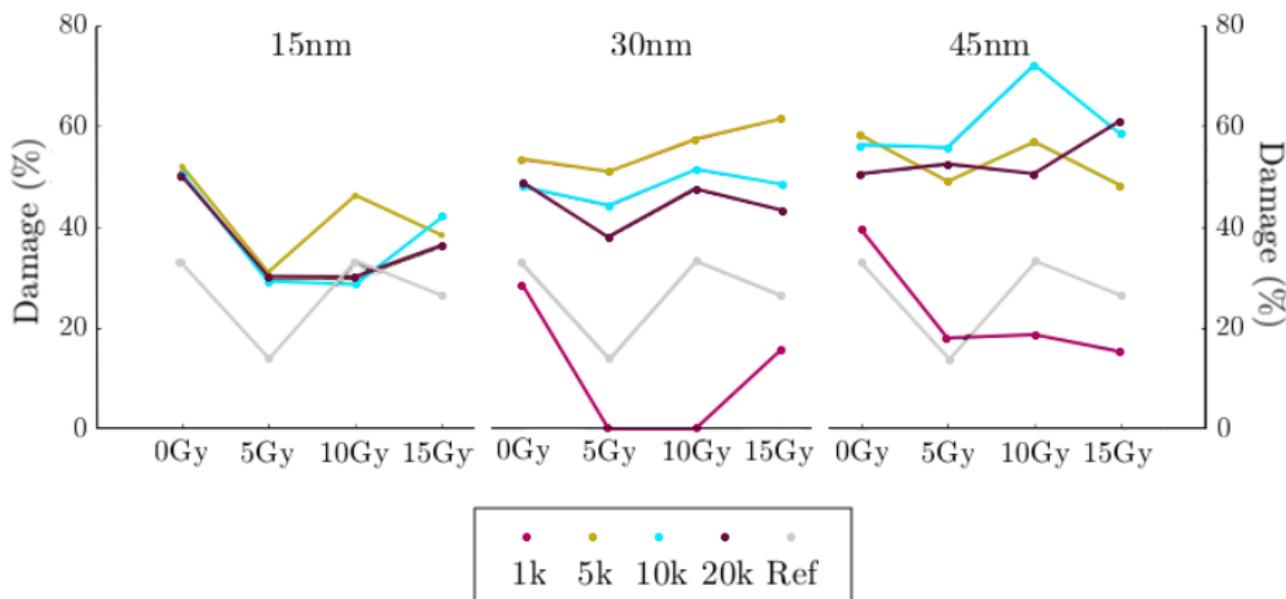


## DNA damage analysis



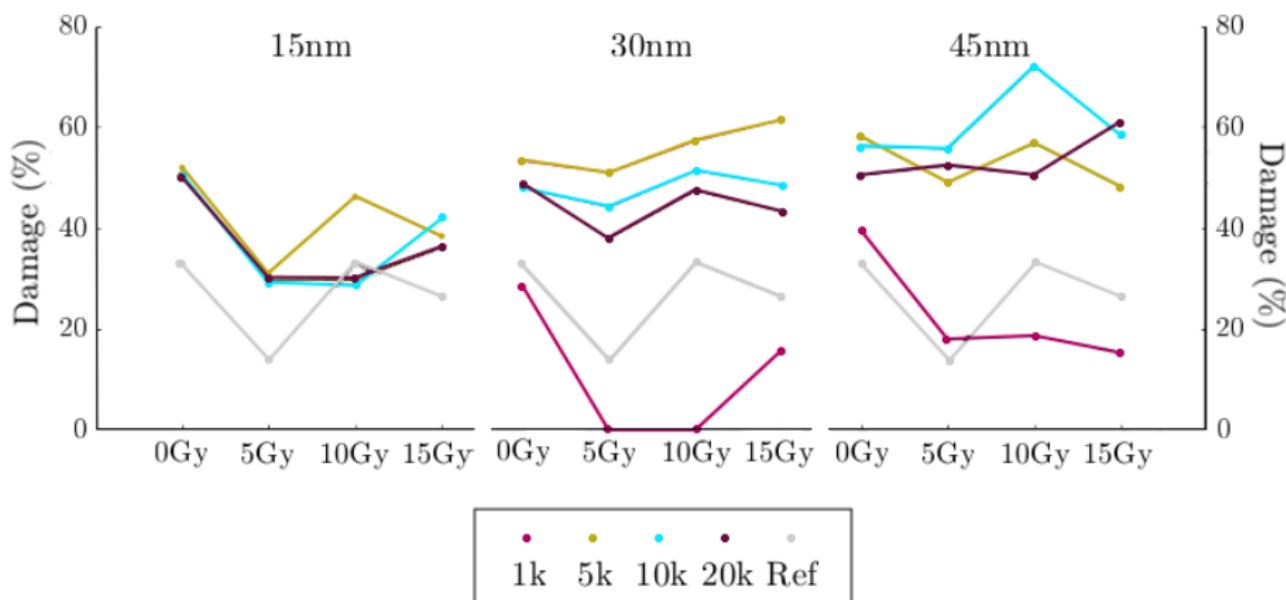
# DNA damage analysis

Strange results for 1 k PEG



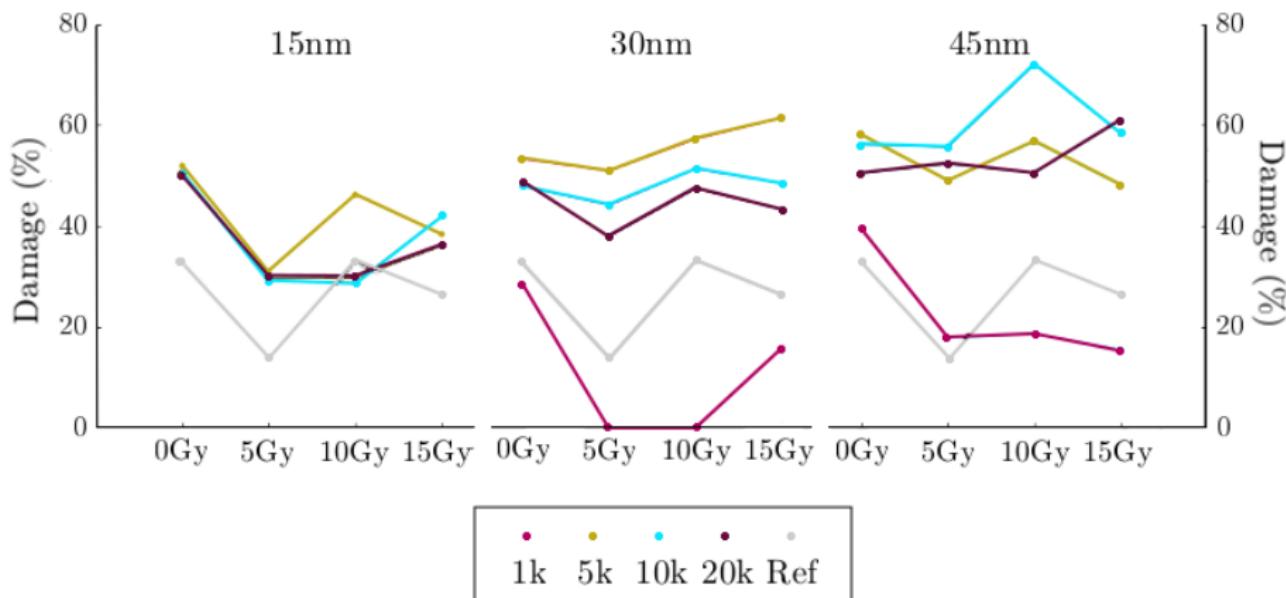
# DNA damage analysis

Curves are not rising



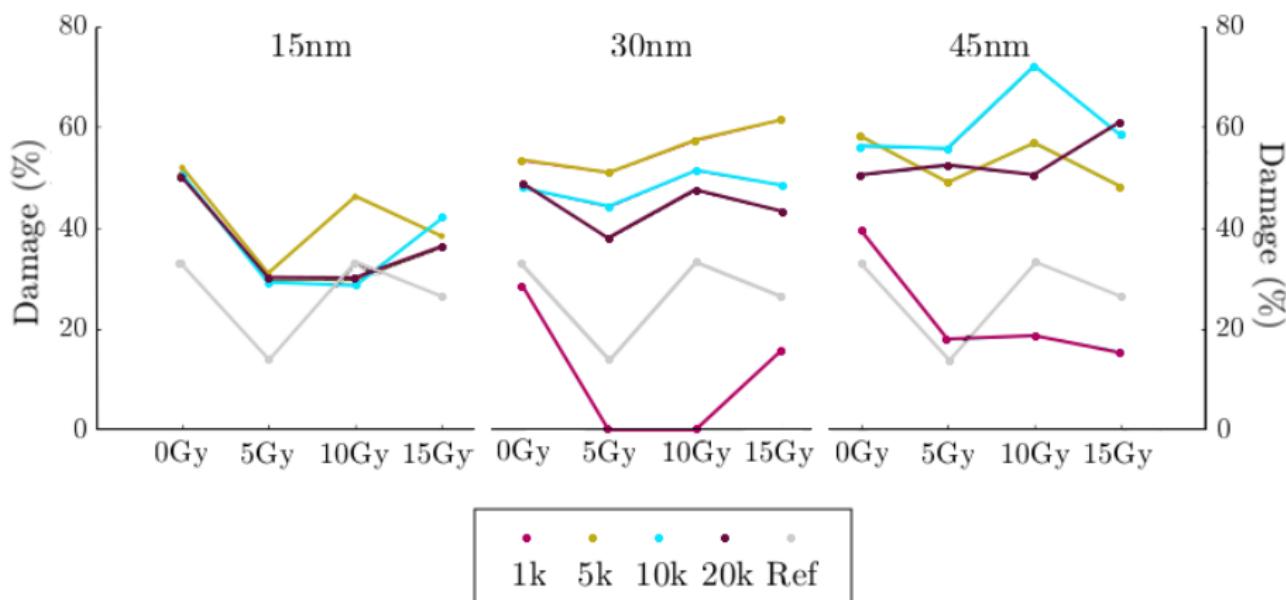
# DNA damage analysis

Reference sample has an unexpected form



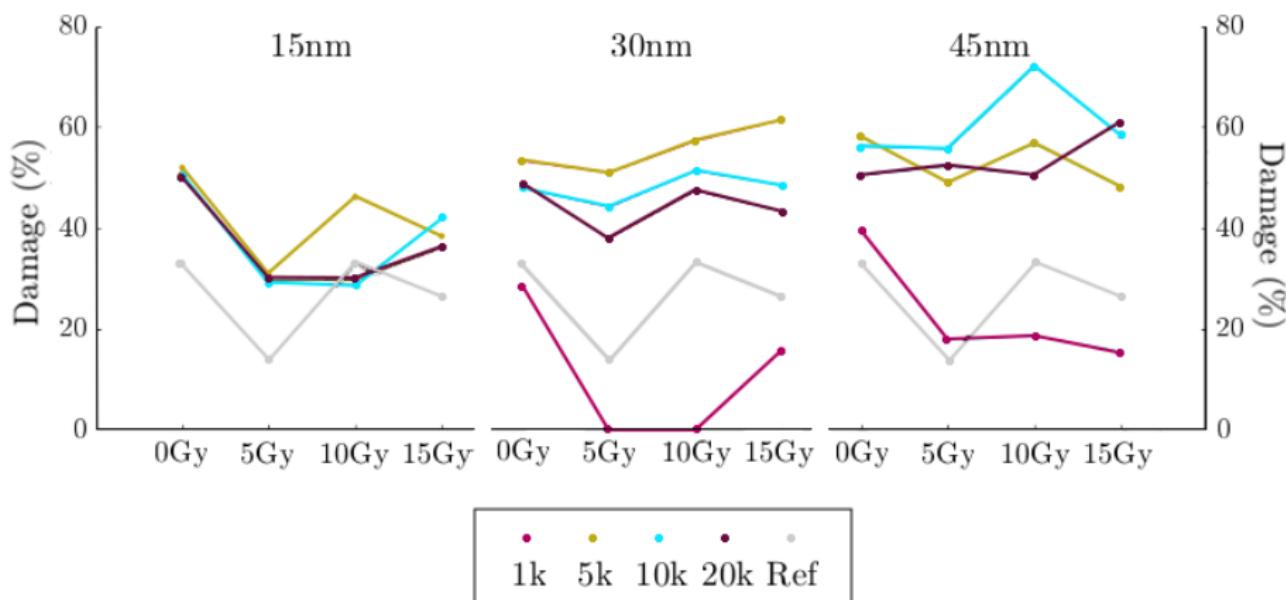
# DNA damage analysis

## DNA damage at 0 Gy



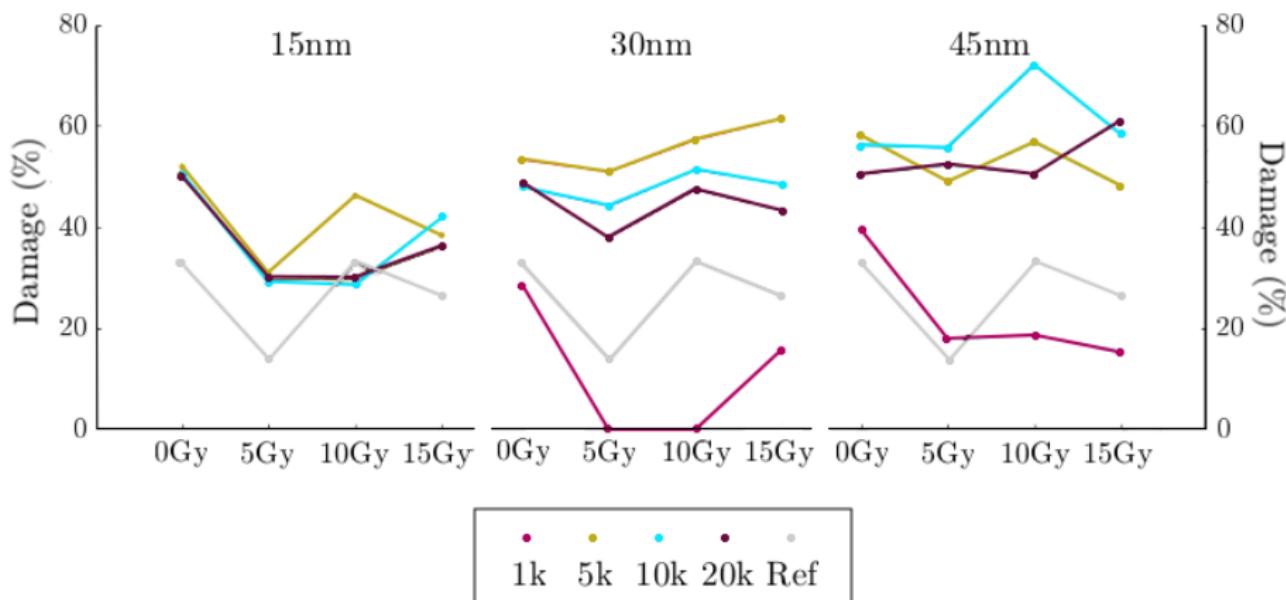
# DNA damage analysis

Radiosensitization effect is present



# DNA damage analysis

Smaller PEG → more DNA damage  
Larger GNP → more DNA damage



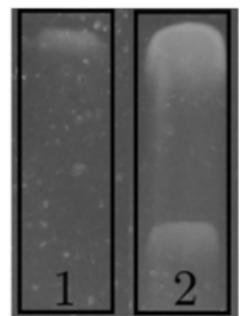
# Conclusion DNA damage analysis

- Strange results for 1 k PEG
- Curves are not rising (except 30 nm GNP)
- Reference sample has strange form
- DNA damage at 0 Gy



# Conclusion DNA damage analysis

- Strange results for 1 k PEG
- Curves are not rising (except 30 nm GNP)
- Reference sample has strange form
- DNA damage at 0 Gy



# Conclusion

- Radiosensitization effect was observed
- Best results with...
  - ...5k functionalization
  - ...largest particles (45 nm)

