Outline

1. Introduction
2. Biology
3. Experiments
4. Experimental Results
5. Some Modelling Assumptions
6. Modelling Uptake

Next talk:
1. Compartment Model
2. Parameter Estimation
3. Modelling Results
4. Future Work
Nanoparticle: 1-100nm (human hair ~ 50,000 nm).

Quantum dots: nanoparticles made from semiconductor materials - CdTe here.

Size-tunable optical properties: green-emitting 2nm, red-emitting 5nm QDs (less aggressive).

Applications: high-resolution cellular imaging, drug delivery, tumour targeting.

Figure: Various sizes of QDs

*Gun’ko group, TCD*
Cell exposure to QDs:
- Cytoplasm granulation
- Loss of functionality
- Nucleus fragmentation
- Chromosome damage
- Cell death

Need to minimize damage:
- QD composition
- Dose
- Exposure time

Figure: TEM image of untreated RAW 264.7 cell (control)
Cells grown for 24 hours.

Co-incubated with coated or uncoated green/red QDs for 12/24 hours.

Three concentrations: 1 nM, 10 nM, 100 nM.

Analyzed using a flow cytometer (identify if cells are healthy, in apoptosis, or in necrosis).
Results

- 1 nM, 10 nM: no deviation from control.
- Drastic change for 100 nM.
- Varied greatly depending on QD parameters.

Cell with Green TGA QDs

Cell with Red TGA QDs
Some Modelling Assumptions

- Four states: healthy, apoptotic, necrotic, dead.
- Healthy cells can enter apoptosis or necrosis.
- Cells in apoptosis or necrosis can die.
- No reversibility.
- Rate at which cells leave healthy state depends on QD concentration.
- Cells uptake QDs via endocytosis.
- Depends on cell type, NP size, shape, surface treatment.
- No data on uptake rates!
- Define a saturation concentration $c_s$ and current intracellular concentration $c(t)$.
- Assume rate of ingestion is proportional to difference between $c_s$ and $c(t)$ so

$$
\frac{dc(t)}{dt} = k_c(c_s - c(t)),
$$

with $c(t = 0) = 0$, giving

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(1)
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