Transformations of Biologically-Conjugated CdSe Quantum Dots Released into Water and Biofilms

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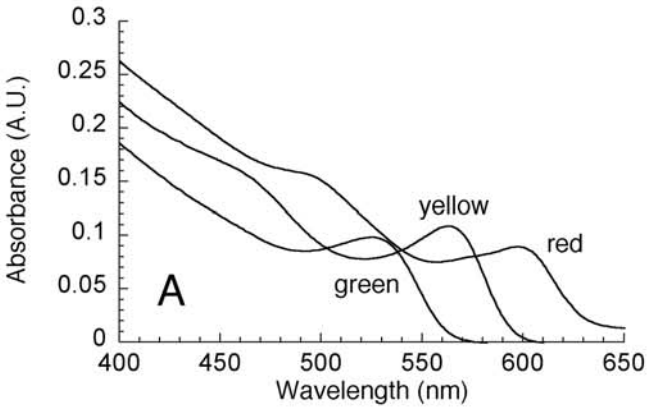
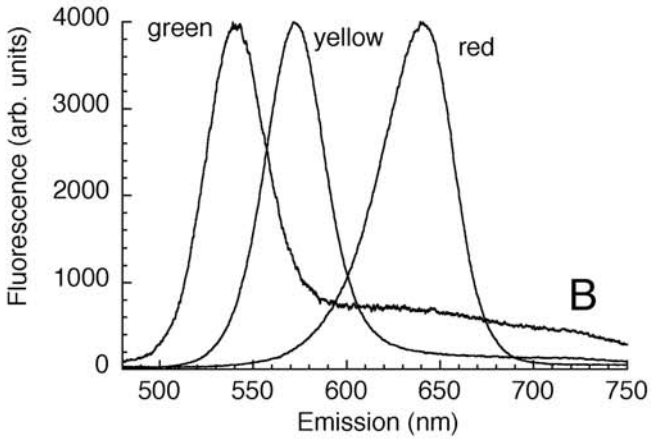
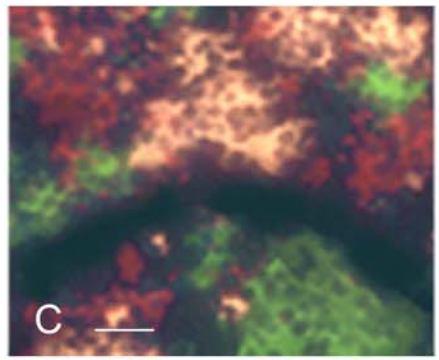
Quantum Dots

- 3 to 7 nm (bare CdSe)
- used in biological labeling
- wide absorbance, narrow emission spectra

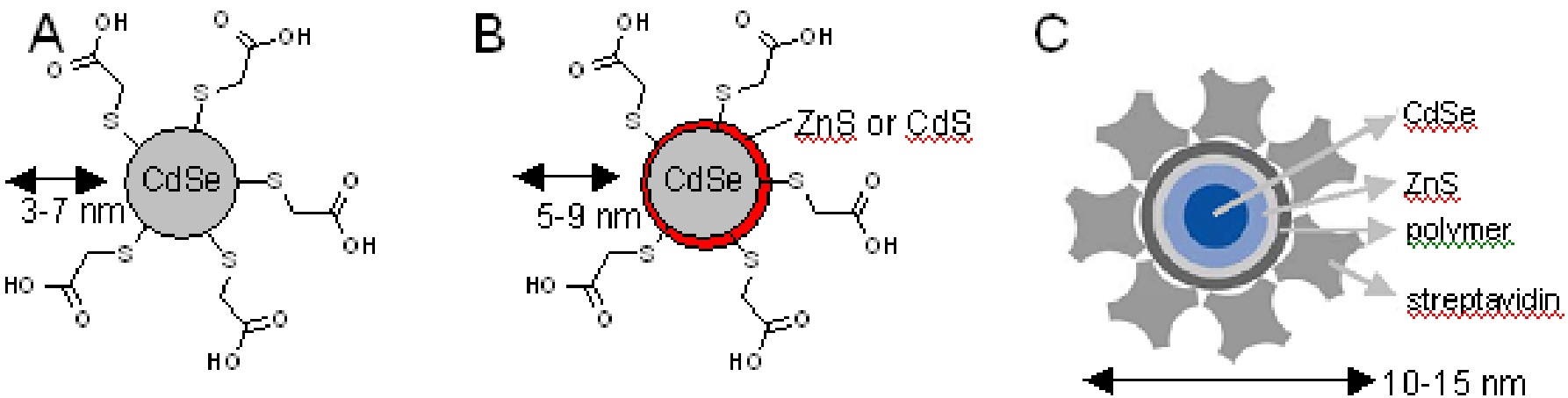






absorbance emission triple-labeled *S. aureus*

Quantum Dots (cont.)



bare core shell conjugated

Project Goals

- Determine fates of CdSe QDs under abiotic and biotic conditions
- Determine toxicity of QDs to bacteria
- Determine damage of QDs to DNA
- Determine how QD coating or conjugation alters effects
- Compare effects of dissolved Cd and Se

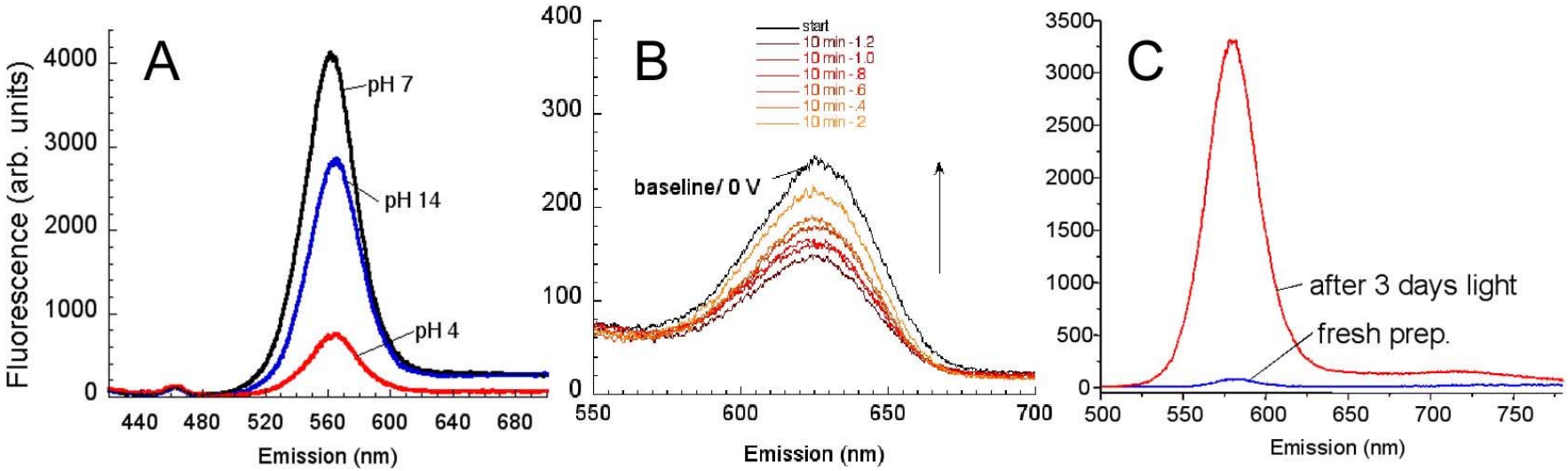
Research Objectives (1/2)

- Quantify QD breakdown in aqueous solutions
  - pH, reducing conditions, light, oxygen
  - bare, core-shell, conjugated QDs
- Quantify microbial uptake and breakdown
  - liquid culture, *S. aureus*, *P. aeruginosa*
  - growth effects, QD fates, breakdown products

Research Objectives (2/2)

- Investigate DNA damage
  - oxidation of isolated G and A by TCSPC
  - oxidation of G in DNA; quantify oxidation product
- Investigate effects <u>on</u> and <u>of</u> bacterial biofilms
  - saturated and unsaturated
  - growth effects, toxicity, & macromolecular interactions
  - breakthrough in colonized porous media

Preliminary Data

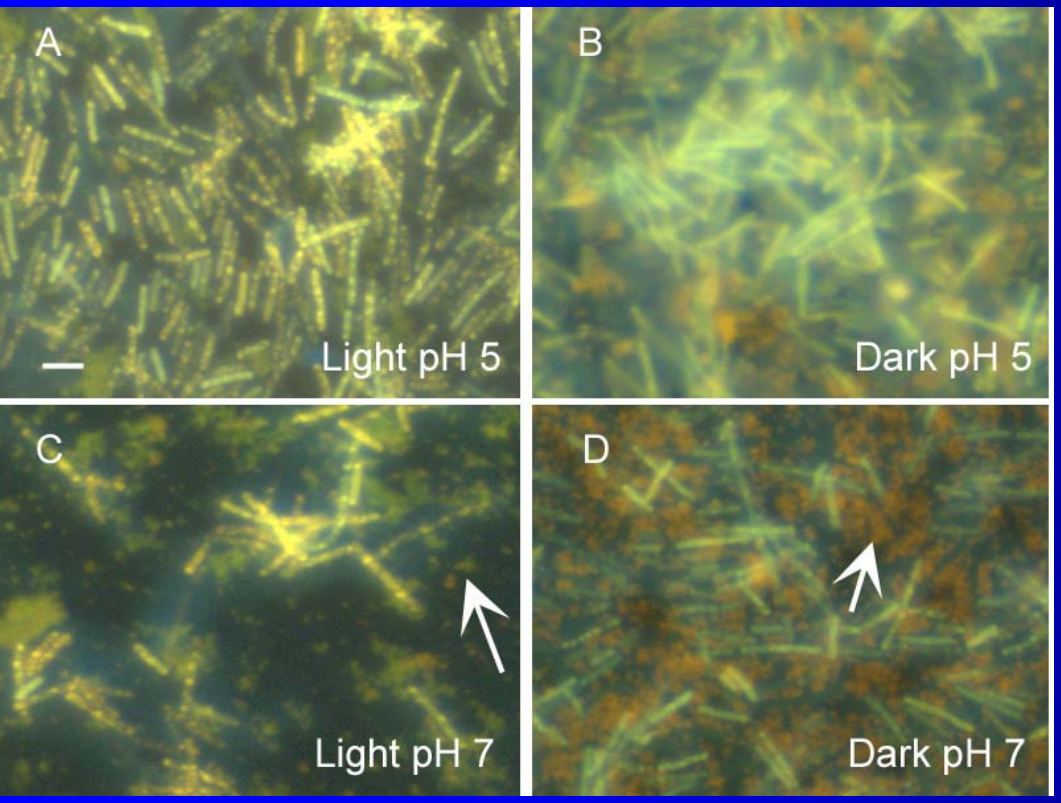


acid quenches more than base (A)

reduction-mediated partial quenching (B)

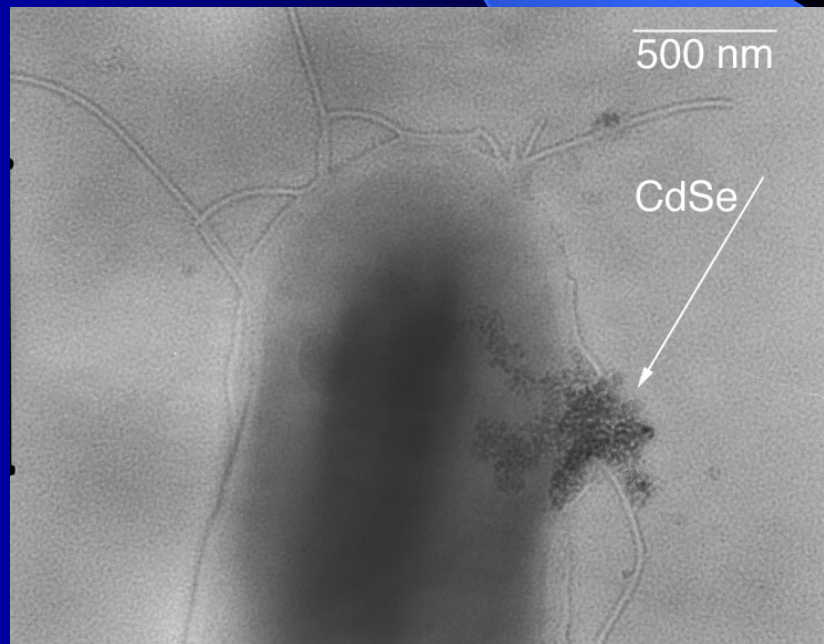
light-mediated fluorescence enhancement (C)

Preliminary Data (cont.)



B. subtilis aprt mutants label brightly with CdSe-AMP QDs (light, pH 5)

QDs effectively stain cells for TEM imaging



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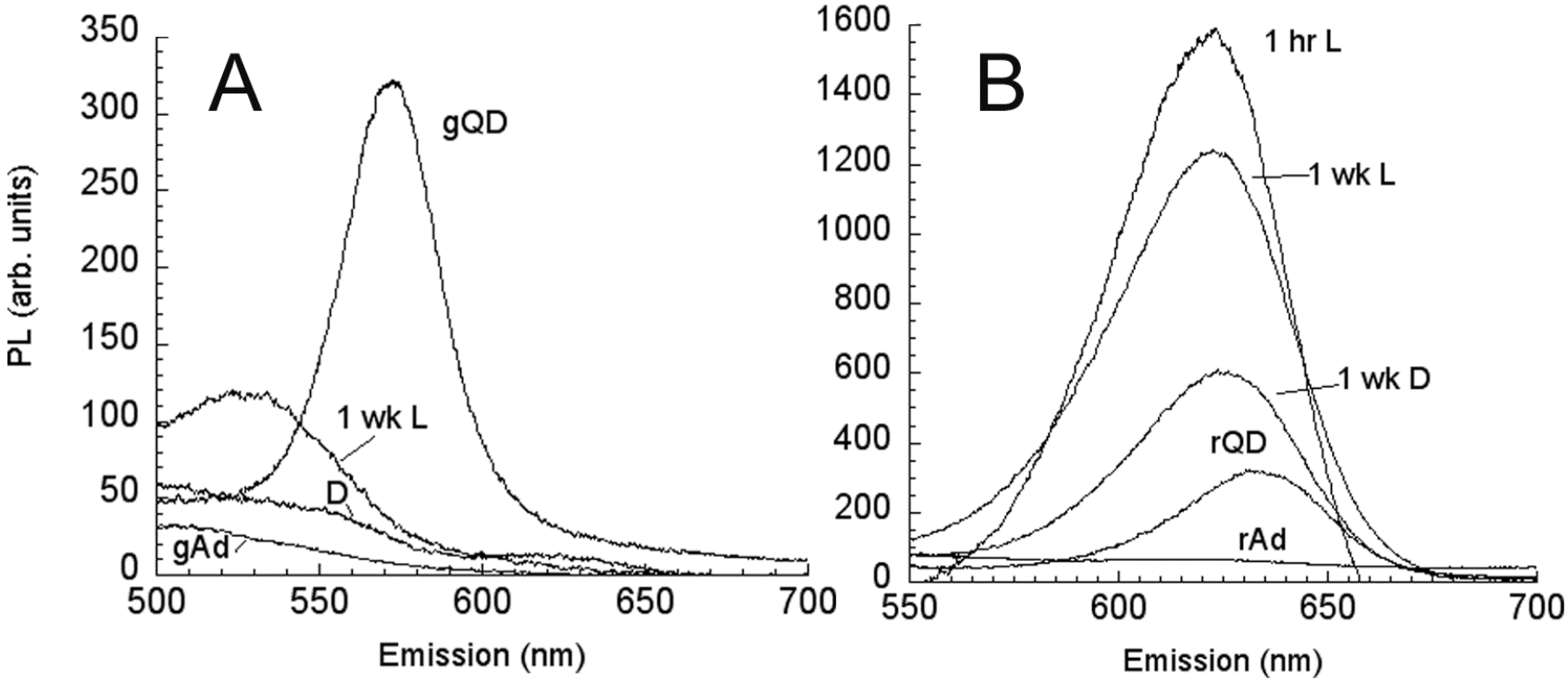

- adenine quenches green (left) and red (right) QDs
- light restores

Project Plans

- 3 years, begin late 2004
- Initially establish protocols across labs
- Nadeau Lab
  - Aqueous fates
  - Liquid culture effects and fates
  - DNA oxidative damage
- Holden Lab
  - Biofilm studies
  - Column breakthrough characteristics

Acknowledgements

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