Quantum Dots: Nanotechnology for Targeted Prostate Cancer Imaging and Therapy

Shuming Nie, PhD
Departments of Biomedical Engineering, Chemistry, Materials Science and Engineering, Hematology and Oncology, and the Winship Cancer Institute
Emory University and Georgia Institute of Technology

Linking Chemistry, Engineering and Medicine: New Opportunities in Biomedical Research

(1) Early Detection and Screening, e.g., Blood and Urine Tests of Cancer, Heart Disease, etc.

(2) In-vivo Molecular Imaging.

(3) Molecular Profiling – Multiplexed Analysis of Genes, Proteins, and Tissue Sections.

(4) Molecular Therapeutics – Multifunctional "Smart" Nanoparticles and Nanodevices for Drug Delivery and Treatment.

(5) Cellular/Tissue Engineering and Regenerative Medicine

(6) Single Molecule Biophysics of Intracellular Transport and Signaling.

Development of Diagnostic and Therapeutic Nanoparticle Agents

(1) Semiconductor Quantum Dots (Fluo and EM)

(2) Metallic Nanoparticles (SERS, SRP, Thermo)

(3) Metal Oxide (Superparamagnetic)

(4) Organic/Polymeric Nanoparticles (Drug Delivery and Targeting)

(5) Multifunctional Nanoparticles – Imaging, Detection and Treatment.

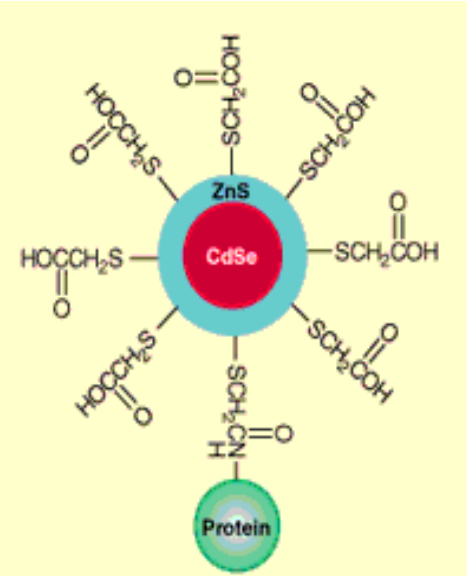
Luminescent Quantum Dots

Quantum dots (QDs): Nanometer-sized semiconductors

Size & material dependent optical properties
High surface/volume ratio

Biological labeling: Colorful tags of biomolecules with highly luminescent QDs

Unique Optical Properties: A superior substitute for organic dyes



Quantum Dots Meet Biomolecules

A. P. Alivisatos et al., Science 281, 2013-2016 (1998).

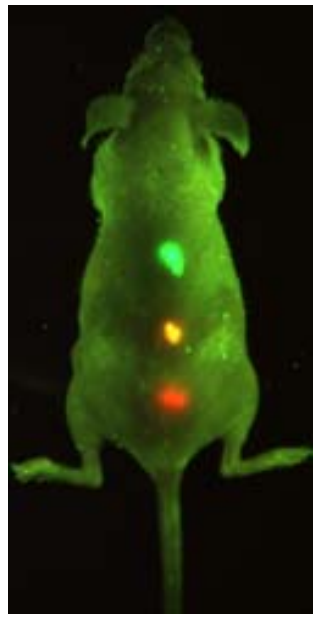
S. Nie et. al., Science 281, 2016-2018 (1998).

Simultaneous Excitation

Ten distinguishable emission colors of ZnS-capped CdSe QDs from blue to red excited with a near-UV lamp.

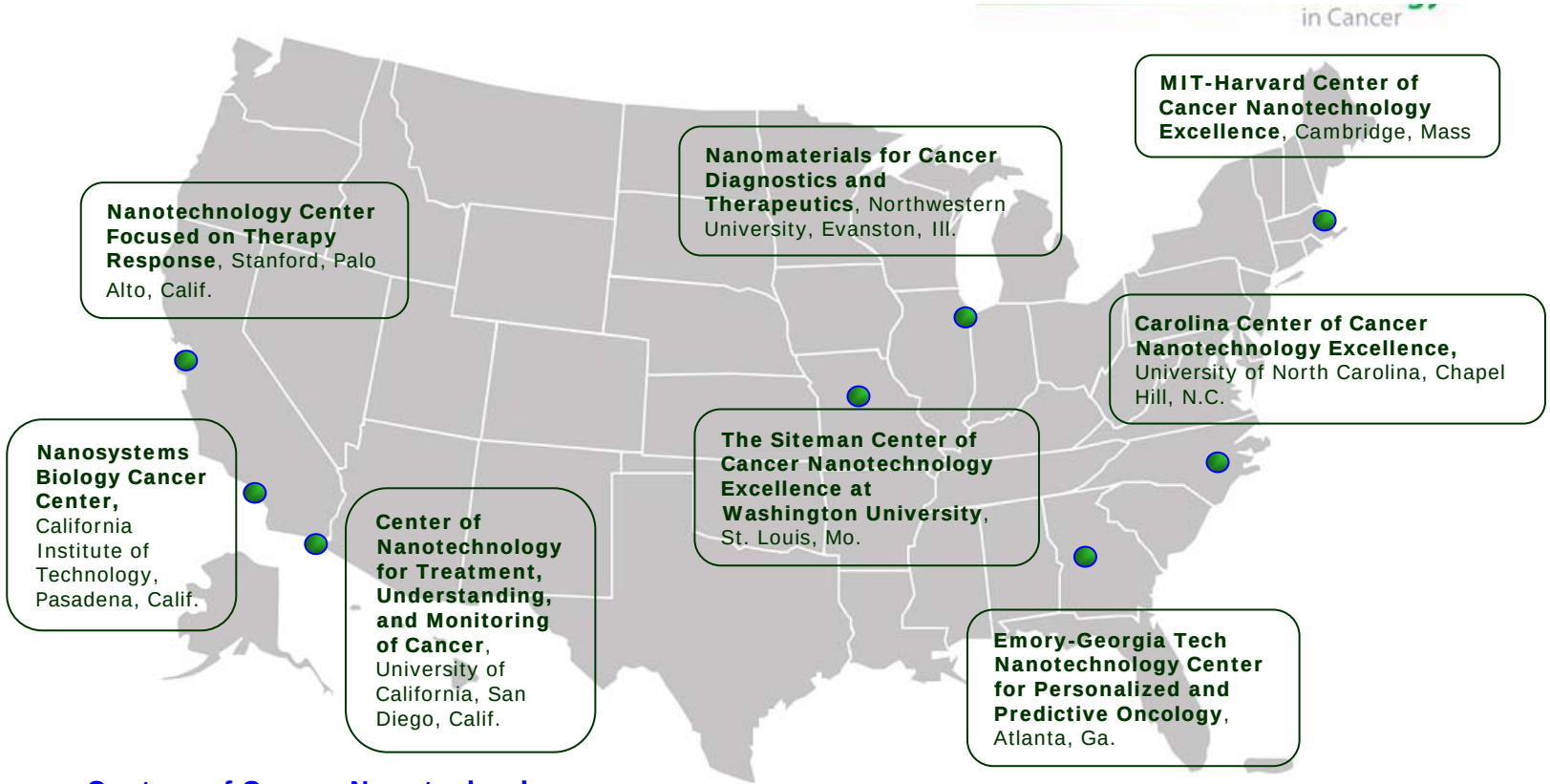
M.Y. Han, X. Gao, & S. Nie, *Nature Biotechnology.* **19**, 631-635 (2001).

Luminescent Quantum Dots for In-Vivo Imaging and Targeting



Gao and Nie, Nature Biotechnology 2004

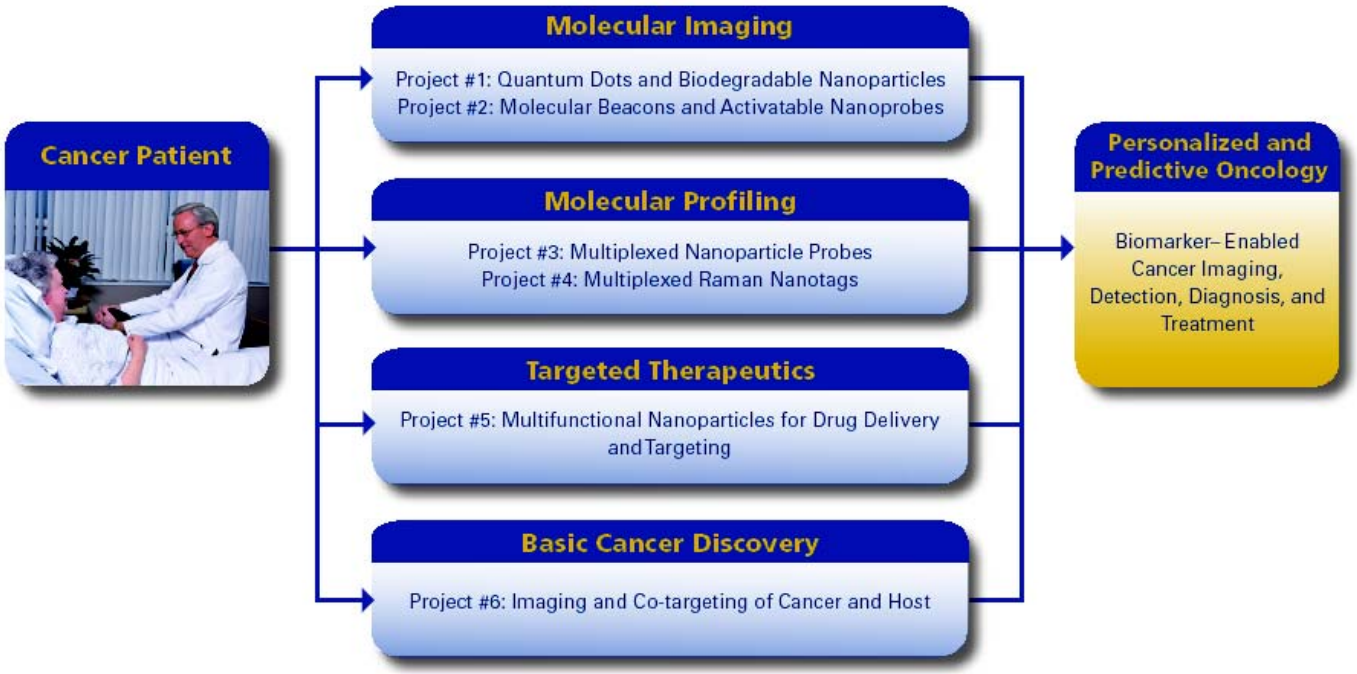
National Centers of Cancer Nanotechnology Excellence (CCNE)



Centers of Cancer Nanotechnology Excellence (CCNE)

Emory-Georgia Tech Nanotechnology Center for Personalized and Predictive Oncology

PI: Shuming Nie (PhD – Nanotechnology)
Co-PI: Jonathan Simons (MD – Clinical Oncology)



Challenges and Opportunities for Nanoparticle Imaging and Therapy In-Vivo:

1. Biocompatibility and Blood Circulation Time (How to Pass the Liver?) – Size, Shape, and Surface Coatings.
2. In-vivo Distribution and Pharmacokineitcs.
3. Cellular and Organ Targeting.
4. Intracellular Release and Transport.
5. Excretion, Degradation, and Metabolism.
6. Long-Term Fate and Toxicology.
7. Balance of Benefits/Efficacy vs. Side Effects.

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