



# Get the most out of your Research

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Collegiate Science and Technology Entry Program  
Workshop

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# Motivation for this Presentation

- Increase your familiarity
- Improve your understanding
- Add to your longevity



What does getting the most out of your  
research mean to

YOU



Grade Yourself :

Future research aim is to become  
highly proficient on the

RUBRIC



# Getting ideas from the best

“

To steal ideas from one person is plagiarism, to steal ideas from

”

- Humorous quote w/real connotations



# Exercise : Who should you know

Write down your major

What are 3 active areas of research

Name 10 highly reputable researchers in your field.

First try this w/o using resources, then use resource like the internet for assistance



# Priorities of a Researcher

Creating new Knowledge

Grant Money

Publications

Reputation

Good researchers in the lab

Teaching

Science

Presenting

Travel

Invited Talks

Tenure



# Getting the most out of your research

## 1. Understanding research from a perspective of :

- Accomplishments
- Abilities
- Culture
- Character
- Skill Set

## 1. Then applying the knowledge obtained to gain a competitive advantage that enhances collaborations and easily allows you to navigate paths of anticipated complexity





# Abilities

Getting the most out of your research



# ABILITIES

Speaking

Reading

Writing

Designing

Funding



# Good scientists talk talk talk

The ability to talk well is the single most important ability of a researcher

Research talk includes

- Selling your research
- Effective Presentations
- Elevator speech
- Story telling
- Chalk Talk



# Selling your research

Name your topic

- I am studying .....

Imply your question

- Because I want to find out who/how/why.....

Set the rationale for the question and the project:

- In order to understand how/why what .....

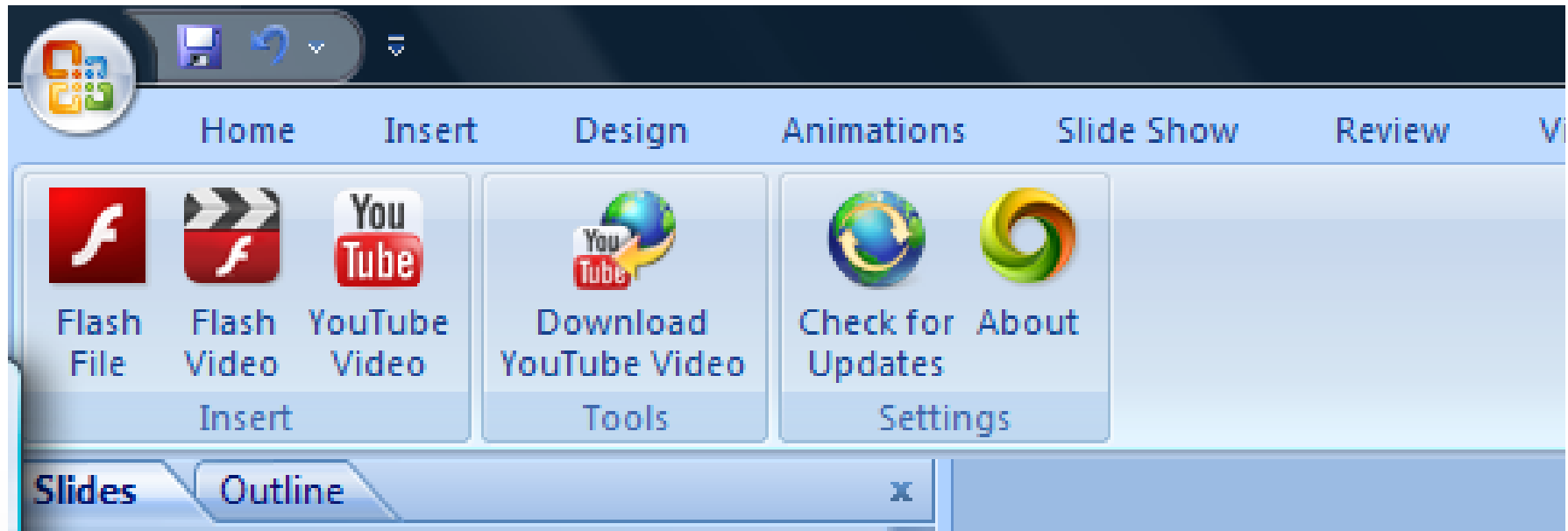


## For an effective talk

- Be optimistic about whatever you are talking about
- Take your time
- Keep your audience in mind
- Connect to real life issue
- Attend Talks
- Look up You Tube Videos
- Look up press releases



# MULTIMEDIA



[http://www.globfx.com/downloads/showroom/formerly\\_swfpoint.php](http://www.globfx.com/downloads/showroom/formerly_swfpoint.php)

Show room  
Swish



# RESEARCH RELATED FLASH



PEG (2000) lipid

Depiction of micelle encapsulation

REACHING  
OTHERS



# YOUTUBE VIDEO - CSTEP







# Getting the most out of your research

## MAXIMUM

Give memorable talks at National meetings

## MINIMUM

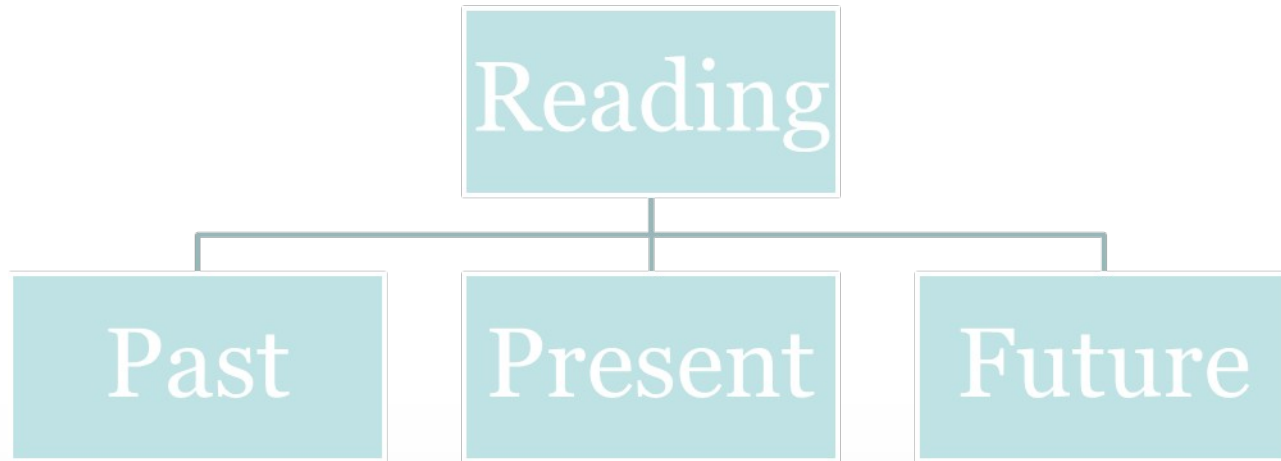
Listen to good talks

To do : Talk with family, friends and acquaintances about your work in a way that gets them excited.

Google good and bad presentations



# READING is key to intelligence



Papers  
Patents

Conference  
Proceedings

Grants



# READING

For Scientific papers :

- Select relevant article (Author, journal)
- Read abstract
- View Figures and read caption
- Read conclusion
- Read paper / check references
- Critique paper/get ideas

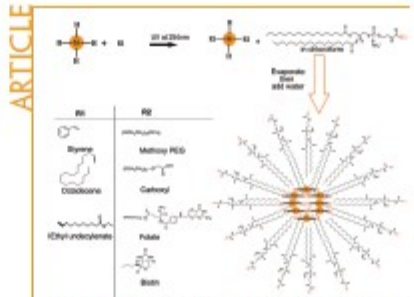


### Biocompatible Luminescent Silicon Quantum Dots for Imaging of Cancer Cells

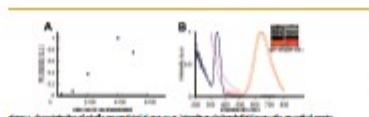
Debrai Singhapong<sup>1</sup>, Kam-Teo Ng<sup>1</sup>, Indrajit Roy<sup>1</sup>, Gailita Dai<sup>1</sup>, Puneet K. Prasad<sup>1</sup>, and Mark T. Heston<sup>1,2\*</sup>

**Q**uantum dots (QDs) have attracted great attention for use as optical probes in biological imaging. However, their use in imaging of cancer cells has been limited by their toxicity and poor biocompatibility. Here, we have developed a novel class of biocompatible luminescent silicon quantum dots (SiQDs) for imaging of cancer cells. The SiQDs are composed of a silicon core and a silica shell, which provides excellent biocompatibility and stability in biological environments. The SiQDs are synthesized by a novel method that involves the use of a silicon core and a silica shell, which provides excellent biocompatibility and stability in biological environments. The SiQDs are synthesized by a novel method that involves the use of a silicon core and a silica shell, which provides excellent biocompatibility and stability in biological environments.

ARTICLE

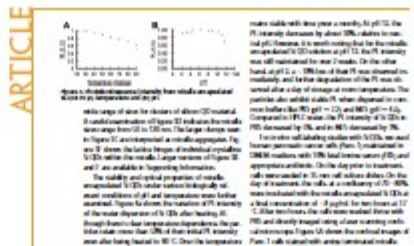


**FIGURE 1.** Schematic of the synthesis of silicon quantum dots (SiQDs) and their functionalization. (a) Synthesis of SiQDs from silicon and hydrogen peroxide. (b) Functionalization of SiQDs with various biomolecules. (c) Application of SiQDs in cancer cell imaging.



**FIGURE 2.** Fluorescence intensity of SiQDs under different conditions. (a) Fluorescence intensity vs. pH. (b) Fluorescence intensity vs. concentration of biomolecules.

ARTICLE



**FIGURE 3.** Stability and biocompatibility of SiQDs. (a) Fluorescence intensity vs. time. (b) Cell viability assay results.

**FIGURE 4.** In vivo imaging of cancer cells using SiQDs. The SiQDs are injected into the tumor and imaged using a fluorescence microscope.

**FIGURE 5.** In vivo imaging of cancer cells using SiQDs. The SiQDs are injected into the tumor and imaged using a fluorescence microscope.

**FIGURE 6.** In vivo imaging of cancer cells using SiQDs. The SiQDs are injected into the tumor and imaged using a fluorescence microscope.

ARTICLE

**FIGURE 7.** In vivo imaging of cancer cells using SiQDs. The SiQDs are injected into the tumor and imaged using a fluorescence microscope.

**FIGURE 8.** In vivo imaging of cancer cells using SiQDs. The SiQDs are injected into the tumor and imaged using a fluorescence microscope.

**FIGURE 9.** In vivo imaging of cancer cells using SiQDs. The SiQDs are injected into the tumor and imaged using a fluorescence microscope.

Read patents for more details



# READING – Conference Proceedings

Ex. ABRCMS, CSTEP, MCNair

-Will be more specified the longer you stay in research



# Grants

- NIH
- <http://projectreporter.nih.gov/reporter.cfm>
- NSF
- <http://www.nsf.gov/awardsearch/index.jsp>



# Getting the most out of your research

## MAXIMUM

Read multiple papers, critique and review relevant literature

## MINIMUM

Read a paper

To do : Read literature that is pertinent to your work, critique it



# Writing abstract

An abstract is a short summary of your completed research. If done well, it makes the reader want to learn more about your research

For an abstract – write :

- Motivation/problem statement
- Methods/procedure/approach
- Results/findings/product
- Conclusion/implications



One or two sentences providing a **basic introduction** to the field, comprehensible to a scientist in any discipline.

Two to three sentences of **more detailed background**, comprehensible to scientists in related disciplines.

One sentence clearly stating the **general problem** being addressed by this particular study.

One sentence summarising the main result (with the words "here we show" or their equivalent).

Two or three sentences explaining what the **main result** reveals in direct comparison to what was thought to be the case previously, or how the main result adds to previous knowledge.

One or two sentences to put the results into a **more general context**.

Two or three sentences to provide a **broader perspective**, readily comprehensible to a scientist in any discipline, may be included in the first paragraph if the editor considers that the accessibility of the paper is significantly enhanced by their inclusion. Under these circumstances, the length of the paragraph can be up to 300 words. (The above example is 190 words without the final section, and 250 words with it).

During cell division, mitotic spindles are assembled by microtubule-based motor proteins<sup>1,2</sup>. The bipolar organization of spindles is essential for proper segregation of chromosomes, and requires plus-end-directed homotetrameric motor proteins of the widely conserved kinesin-5 (BimC) family<sup>3</sup>. Hypotheses for bipolar spindle formation include the 'push-pull mitotic muscle' model, in which kinesin-5 and opposing motor proteins act between overlapping microtubules<sup>4,5</sup>. However, the precise roles of kinesin-5 during this process are unknown. Here we show that the vertebrate kinesin-5 Eg5 drives the sliding of microtubules depending on their relative orientation. We found in controlled *in vitro* assays that Eg5 has the remarkable capability of simultaneously moving at  $\sim 20 \text{ nm s}^{-1}$  towards the plus-ends of each of the two microtubules it crosslinks. For anti-parallel microtubules, this results in relative sliding at  $\sim 40 \text{ nm s}^{-1}$ , comparable to spindle pole separation rates *in vivo*<sup>6</sup>. Furthermore, we found that Eg5 can tether microtubule plus-ends, suggesting an additional microtubule-binding mode for Eg5. Our results demonstrate how members of the kinesin-5 family are likely to function in mitosis, pushing apart interpolar microtubules as well as recruiting microtubules into bundles that are subsequently polarized by relative sliding. We anticipate our assay to be a starting point for more sophisticated *in vitro* models of mitotic spindles. For example, the individual and combined action of multiple mitotic motors could be tested, including minus-end-directed motors opposing Eg5 motility. Furthermore, Eg5 inhibition is a major target of anti-cancer drug development, and a well-defined and quantitative assay for motor function will be relevant for such developments.



# Getting the most out of your research

## MAXIMUM

Write abstract for a top quality research journal  
conveys the work and it's broader impact

## MINIMUM

Write what you did

To do : Read abstract templates e.g. nature abstract,  
rewrite someone else's abstract



## WRITING : Picking templates

Templates are used for just about everything one produces

NEVER WORK WITHOUT A TEMPLATE

Finding Templates

Get Paper Templates – Journal websites

Templates

- Download
- Recreate

Modify old templates

Recycle



# Journal websites

Look for Authors Link

Go to submission and review

You may have to create account

Look for manuscript information

Nature Precedings : doi:10.1038/npre.2011.5702.1 : Posted 18 Feb 2011



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ACS Journals

Ready to submit your manuscript or review?



# WRITING: getting a grant

Grants are the largest source of science funding  
They come from the government, Industry and Academia

To get grants  
Use a single solid idea  
Follow guidelines to the T

Get inside knowledge

- Write conservatively for Government
- Write risky for private
- Write about fundamentals for large co-operations



## NIH Undergraduate Scholarship Program for Individuals from Disadvantaged Backgrounds

### INFORMATION AT A GLANCE

The National Institutes of Health (NIH) Undergraduate Scholarship Program offers scholarship awards to students from disadvantaged backgrounds who are committed to careers in biomedical, behavioral and social science health-related research. The program is sponsored by the NIH, one of the world's foremost centers for biomedical research and research training.

The scholarships pay for tuition and reasonable educational and living expenses up to \$20,000 per academic year. In return, recipients are obligated to serve as paid employees in NIH research laboratories during the summer and after graduation. In addition to financial assistance, the scholarship program offers invaluable training and mentoring, as well as practical experience in a state-of-the-art research setting.



# Getting the most out of your research

## MAXIMUM

Life (Career) time funding from a single source such as the National Institute of Health (NIH)

## MINIMUM

(Don't) Apply

To do : look up [grants.gov](http://grants.gov), NIH grants, NSF grants that are suited to you.



# Abilities : design experiments

Planned experiments let you and everyone know where you're going

Allows you to know the feasibility

- To Design experiments
- Start from paper idea that is publishable
- Sketch required figures
- Understand available equipment
- Watch out for unexpected results



- Follow a design process to develop an idea in steps from **coarse** to **fine**:

**First Step: Evaluate the resources that are available**

**Second Step: Carefully study the problem and make sure you have a clear understanding of what needs to be done and what are the constraints (rules, limits)**

- Steps 1 & 2 are often interchangeable

**Third Step: Start by creating possible strategies using words, analysis, and simple diagrams**

Imagine possible motions, data flows, and energy flows from start to finish or from finish back to start!

Continually ask “Who?”, “What?”, “Why?”, “Where”, “How?”

Simple exploratory analysis and experiments can be most enlightening!

Whatever you think of, others will too, so think about how to defeat that about which you think!

**Fourth Step: Create concepts to implement the best strategies, using words, analysis, and sketches**

Use same methods as for **strategies**, but now start to **sketch ideas**

Often simple experiments or analysis are done to investigate effectiveness or feasibility

Select and detail the best **concept...**

**Fifth Step: Develop modules, using words, analysis, sketches, and solid models**

**Sixth step: Develop components, using words, detailed analysis, sketches, and solid models**

**Seventh Step: Detailed engineering & manufacturing review**

**Eighth Step: Detailed drawings**

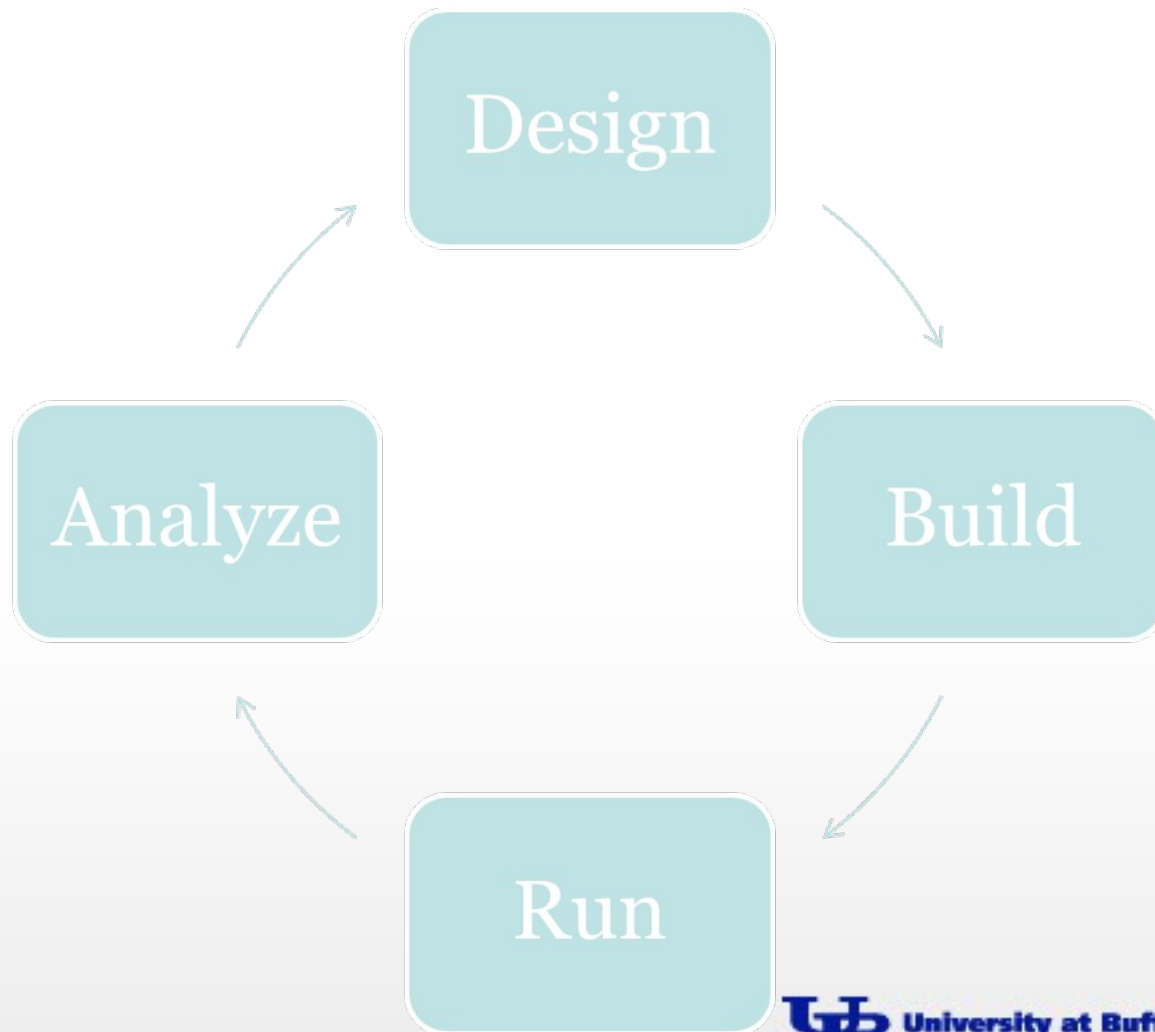
**Ninth Step: Build, test, modify... –**

**Tenth Step: Fully document process and create service manuals...**

Nature Precedings : doi:10.1038/npre2011.5702.1  
Posted 18 Feb 2011



# GET TO KNOW DEBRA





## Abilities : analyze

- Because you follow a procedure - do not blindly expect it to work
- Use error margin
- Compare to literature and reference values
- View patents of the same publications



# Getting the most out of your research

## MAXIMUM

Design high quality experiments that others can execute and think is reasonable

## MINIMUM

Look up figures in papers to understand experimental design

To do :put your experiments in the context of a design , design a new project, motivate someone



## Ability : Scientist draw

A schematic indicating what you think a process is key.

To draw schematics :

View previous images on the concept you want to convey

Notice details you can improve

Tailor image to your preference based on understanding of your project

Draw large and reduce later

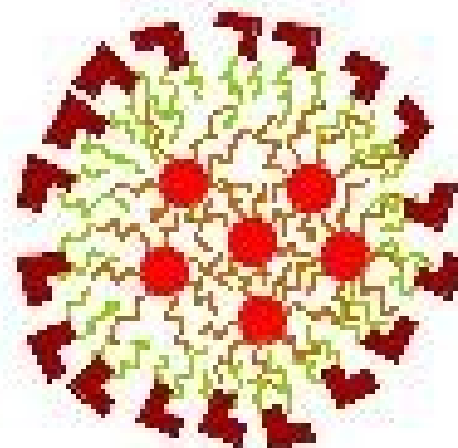
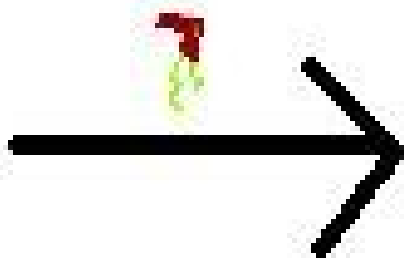
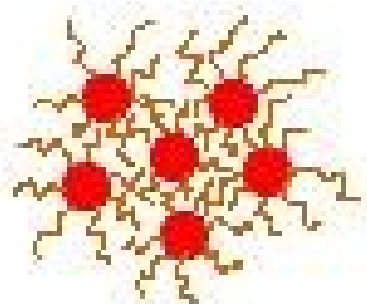
Use software like

- Adobe Products (Photoshop, Fireworks)
- Chem Draw



# SCHEMATIC - development

DSEP - PEG  
phospholipid



 Silicon quantum dot

 ethyl undecylenate

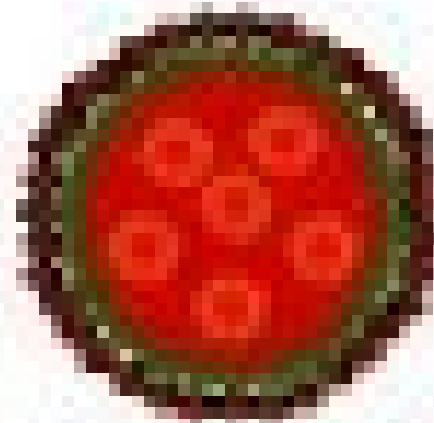
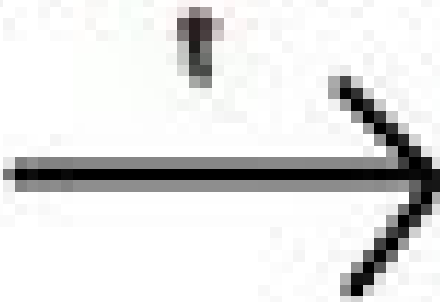
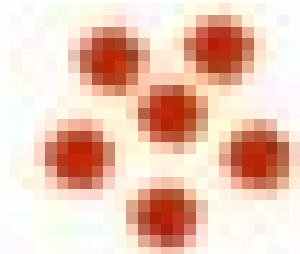
 hydrophilic head

 hydrophobic tail



# SCHEMATIC –blurry

DSPE + PEG  
nanospheres



● Silicon quantum dot

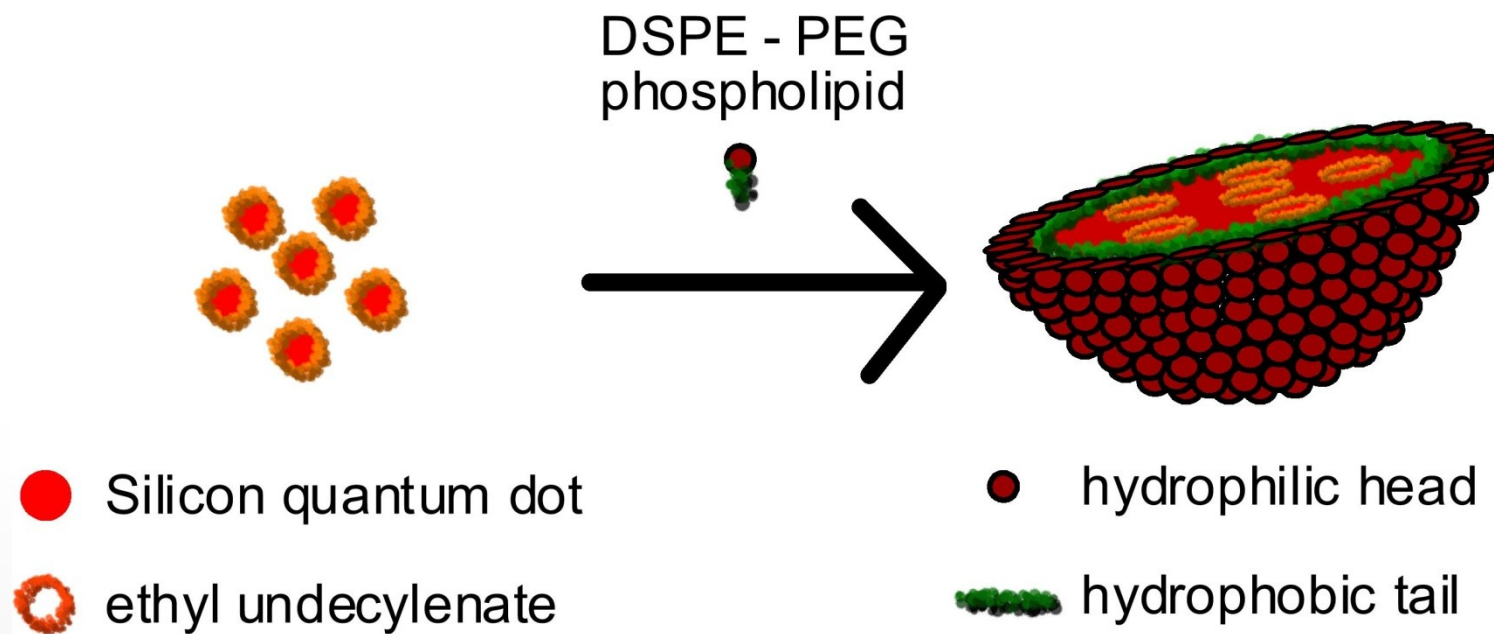
○ Hydrophobic head

● Hydrophobic head

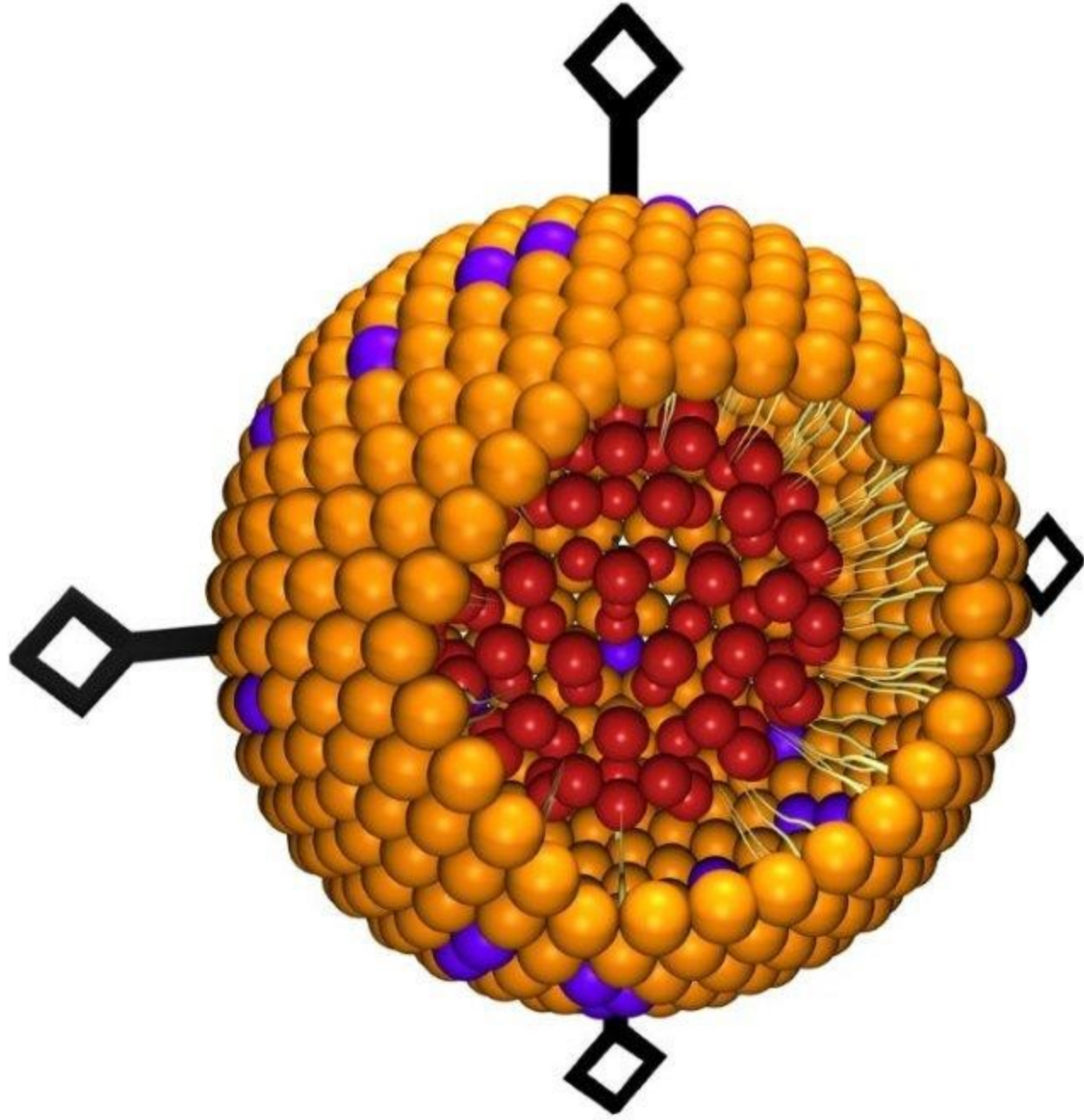
— Hydrophobic tail



# SCHEMATIC - DEVELOPMENT









# Getting the most out of your research

## MAXIMUM

Use simulation software / graphic designer to create your graphic and flash animation

## MINIMUM

Copy graphic from another

To do : learn how to illustrate concepts



# Poster


- Follow the Judges Rubric
- Start by sketching it out
- Use graphics, arrows, and supporting text
- Include white space
- Significance of work, problems addressed and conclusions should be obvious
- Use active voice when writing the text.
- Delete all redundant references and filler phrases
- Self-explanatory graphics should dominate the poster.
- Use san-serif fonts

# In Vivo Targeted Cancer Imaging and Lymph Node Mapping with Silicon Nanocrystals

## Multidisciplinary Motivation

## Abstract


**Silicon Nanocrystals**



Safe, Cheap, Light emitting, particles

**Problem:** How do you make them?


**Cancer**



Very Deadly Disease

**Problem:** How do you detect it?


**Tumor Targeting**



Find the Tumor

**Problem:** Can you do it non-invasively?

**Lymph Node Mapping**



Cancer can spread via lymph

**Problem:** Can you tell if it has spread?

Quantum dots (QDs) have size-dependent optical properties that make them uniquely advantageous for *In vivo* targeted fluorescence imaging, traceable delivery, and therapy. The use of group II-VI QDs (e.g., CdSe) for these applications is advancing rapidly. However, group II-VI QDs contain toxic heavy metals that pose a threat to organs, and thus for *In vivo* applications, there is a need to replace these materials with a more biocompatible semiconductor, such as silicon. Here we demonstrate that, with proper preparation and encapsulation, biocompatible silicon QDs (Si QDs) can be used in multiple cancer-related *In vivo* applications, including tumor vasculature targeting, sentinel lymph node mapping, and multi-color NIR imaging in live mice. This work overcomes previously insurmountable challenges to *In vivo* imaging with, and efficient targeting of, Si QDs through a unique nanoparticle synthesis, surface functionalization, PEGylated micelle encapsulation, and biocirculation process that produces bright, targeted nanoparticles with stable luminescence and long (>40 hr) circulation times *In vivo*. With this demonstration, we anticipate that Si QDs will now be able to play an important role in more sophisticated *In vivo* models, by alleviating QD toxicity concerns, while maintaining the key advantages that have generated such intense interest in QD-based imaging methods.

## Problem


In order to address the above problems, light emitting semiconductor nanocrystals have been investigated world wide. Most demonstrations contain toxic components (E.g. Cadmium) that prevent the adoption of these nanocrystals for clinical use.

**Solution:** Make non-toxic light emitting silicon nanocrystals (for cancer)

## Applicable Methods (to make silicon nanocrystals)

**Step 1: Decompose Silane Gas**

High-Temperature Laser Pyrolysis of Silane



Result 1: Obtained dust-like particles

## Step 2: Treat Particles with acid

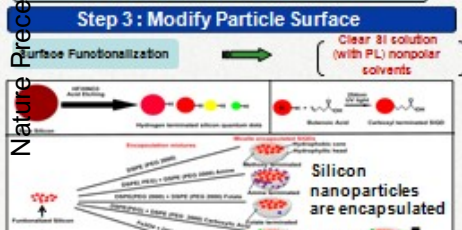
Controlled Etching to Establish Luminescence



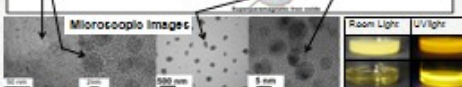
Result 2: Obtained particles with different colors

## Step 3: Modify Particle Surface

Surface Functionalization



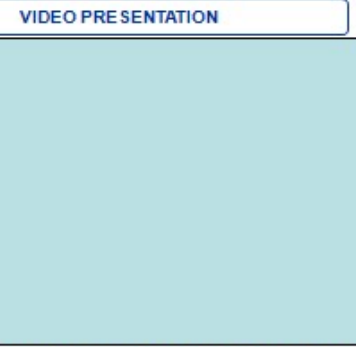
Silicon nanoparticles are encapsulated



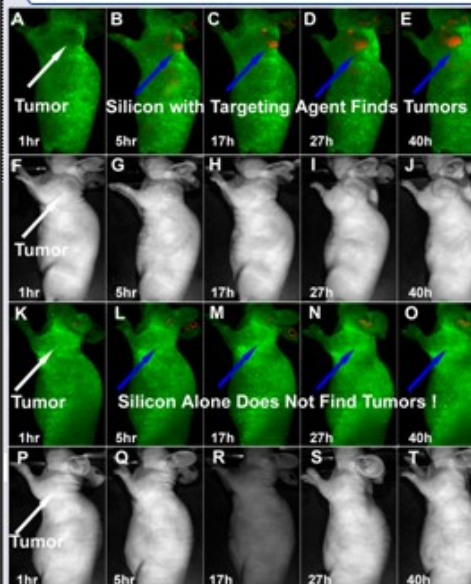
Result 3: Particles become quality imaging Agents

Can the particles be applied to live animals (mice)?

## Data and Conclusions (Silicon can safely be used for Cancer Imaging applications)

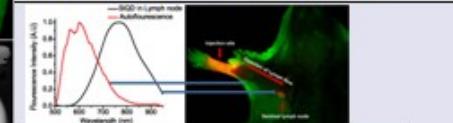


## MAJOR RESULTS: TUMOR TARGETING, LYMPH NODE MAPPING & MULTI-COLOR IMAGING IN MICE



**Conclusions**

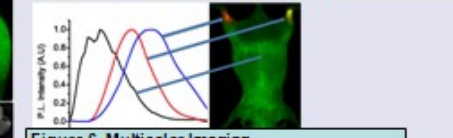
- Silicon nanocrystals are useful for tumor detection
- They have long blood circulation time
- They are compatible with the immune system
- They are stable in the tumor environment



## Figure 5. Lymph node mapping

**Conclusions**

- Can be Useful for finding out if cancer has spread
- Can identify the lymph node
- Can provide surgical image guidance



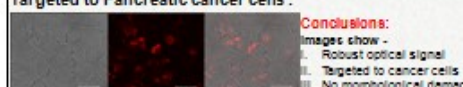
## Figure 6. Multicolor Imaging

**Conclusion**

- Near Infrared (invisible light) peaks from silicon are visible
- They are easily distinguished *in vivo* after subcutaneous injection
- Useful Potential for distinguishing cancer molecules

## In Vitro Imaging

**Targeted to Pancreatic cancer cells:**



**Conclusions:**

- Optical images show -
- Robust optical signal
- Targeted to cancer cells
- No morphological damage

Figure 7. Targeted delivery of Si QDs to cancer cells: the transmission image, luminescence image, and an overlay of the two

**Magnetically guided Silicon QDs:**



**Conclusions:**

- Optical and magnetic
- Increased particle uptake
- Guided to cancer site
- MRI potential
- Treatment potential

Figure 8. Micelle-co-encapsulated Si QDs and superparamagnetic iron oxide. Top (No magnet), Bottom (Magnet)

left to right, the panels show: transmission and luminescence image.

## Cellular and Live Mouse toxicity

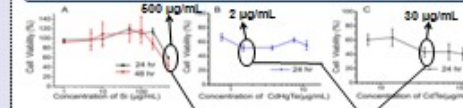


Figure 9. Cellular Toxicity studies

**Si toxicity at (500 µg/mL) is similar to that of CdTe at 10 µg/mL or CdTe at 30 µg/mL**

**Conclusions:**

- Si nanocrystals are 5-50 times less toxic than Cd based nanocrystals in cells
- No sign of adverse effects in the major organs over 8 weeks
- Silicon has low toxicity and improves the chances of using semiconductor nanocrystals in

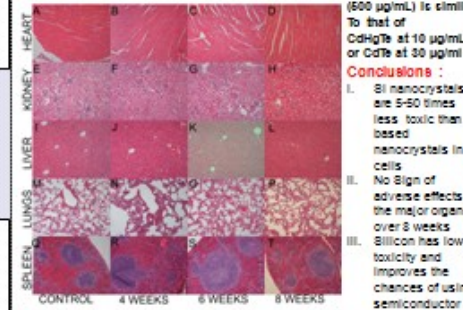


Figure 10. Microscopic images of major organs in mice



## San-serif fonts

**AaBbCc** Sans-serif font  
**AaBbCc** Serif font  
**AaBbCc** Serif font  
(serifs in red)



# Getting the most out of your research

## MAXIMUM

Create a great poster by taking advantages of your presenting good work and what you think is appealing  
Insert your creativity

## MINIMUM

Create a poster with all the basic components

To do : Look up posters on your department walls,  
create a good poster.



# Getting the most out of your research

## MAXIMUM

Write your paper in the best template, design high quality poster template

## MINIMUM

Google and download templates

To do : Find templates relevant to your work for papers, poster



## ABILITIES CONCLUDED

- Talking can lead to reputation suicide – do it well well
- Multimedia is like adding spices to bland food
- Reading contains golden nuggets of info
- Drawing is not only for art majors
- Designing research is key to credit
- Abstracts are your salesman
- Get creative and effective with posters
- Templates reduce work load



REACHING  
OTHERS



# QUESTIONS

Nature Precedings : doi:10.1038/npre.2011.5702.1 : Posted 18 Feb 2011