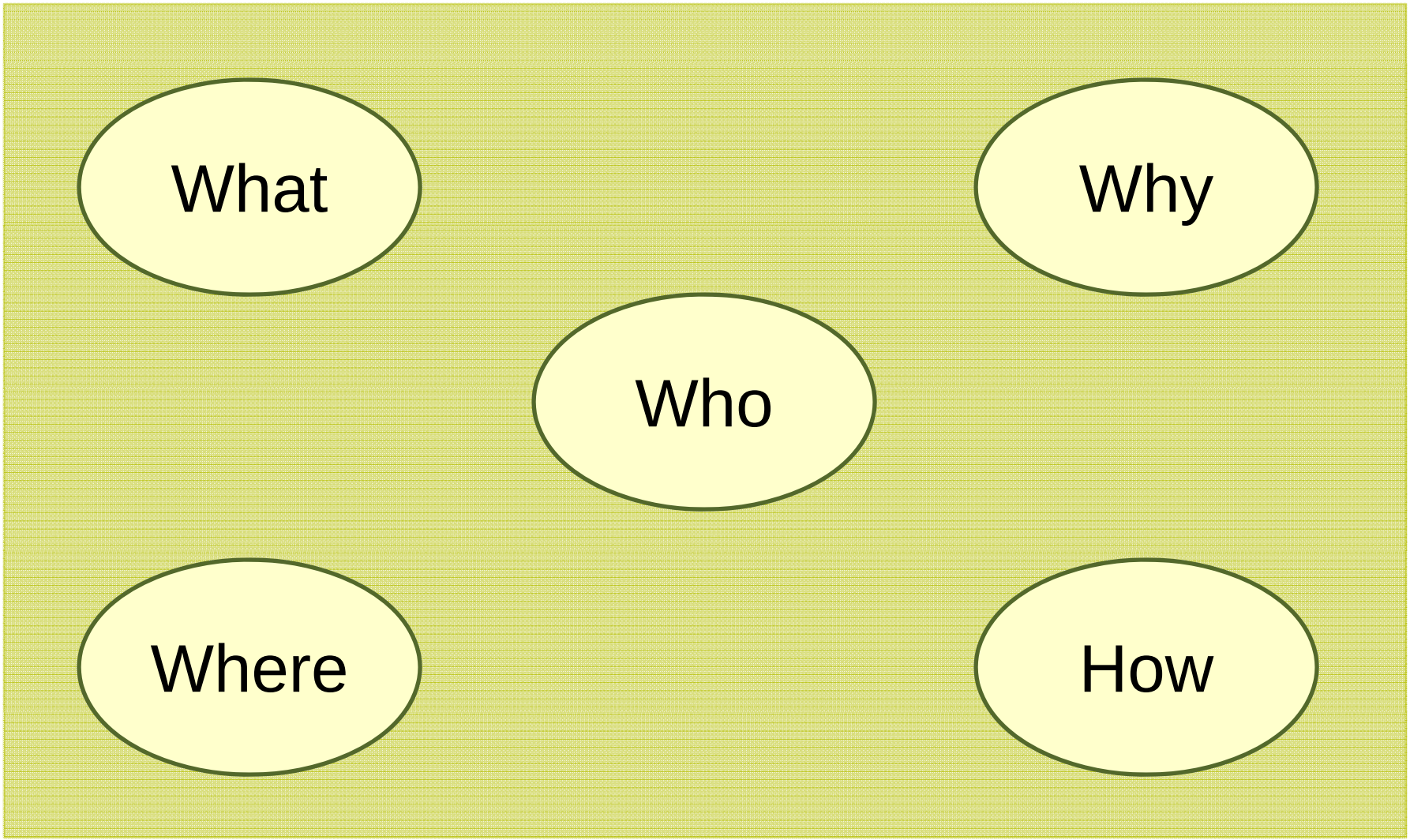
Nano 101:
Exploring the Nanoworld

NISE network
NANOSCALE INFORMAL SCIENCE EDUCATION

NSF

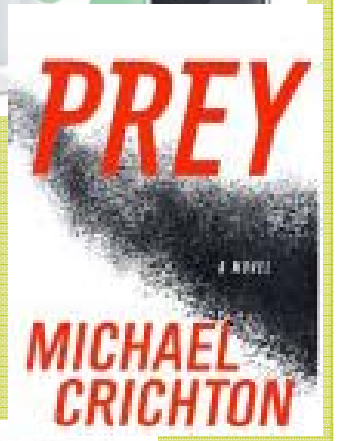
Outline



“Nano” All Around Us

Tata Nano

Self-cleaning windows



VX Nano Cordless Laser Mouse

Samsung washing machine

Apparel with silver nanoparticles

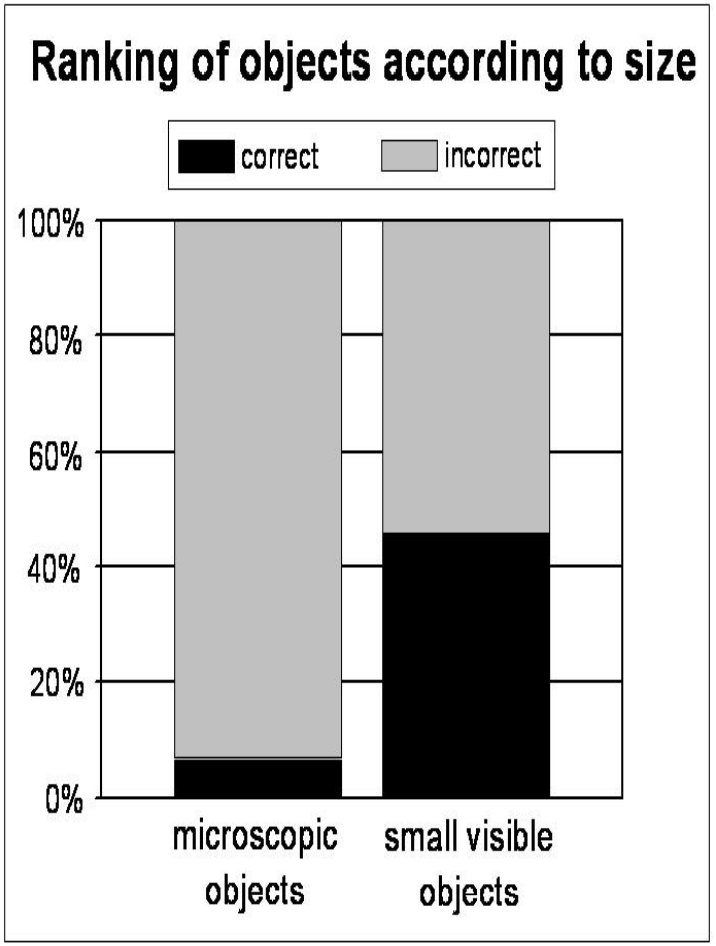
Baby gear

But what is nanotechnology?

Nano Not Widely Understood

Science & Engineering Indicators 2008

- 20% knew “some” or “a lot” about nanotech
- 54% knew nothing at all
- But supportive



2004

Nanotechnology: Small, Different, New

Federal definition (NNI)

Nanotechnology is the understanding and control of matter at dimensions of roughly 1 to 100 nanometers, where unique phenomena enable novel applications.

Encompassing nanoscale science, engineering and technology, nanotechnology involves imaging, measuring, modeling, and manipulating matter at this length scale.

Public definition

1. The nanometer is extremely small.
2. At the nanometer scale, materials may behave differently.
3. We can harness this new behavior to make new technologies.

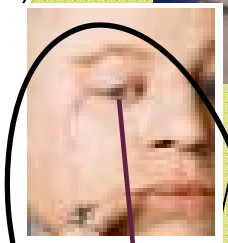
Nanometer: Part of The Metric System

kilometer	km	1,000	$1X10^{3}$
meter	m	1	$1X10^{0}$
millimeter	mm	1/1,000	$1X10^{-3}$
micrometer	μm	1/1,000,000	$1X10^{-6}$
nanometer	nm	1/1,000,000,000	$1X10^{-9}$
picometer	pm	1/1,000,000,000,000	$1X10^{-12}$

Size and Scale: Factors of 1000

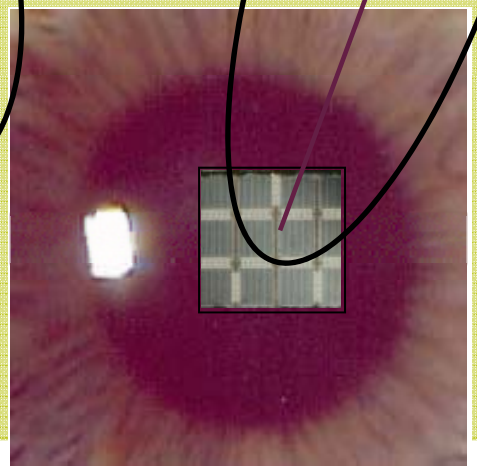
10^0

meters



10^{-3}

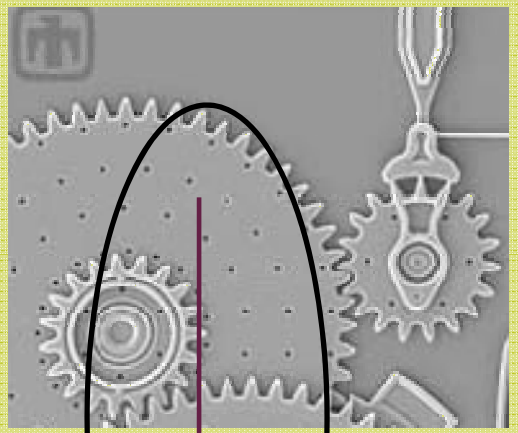
millimeters



Courtesy of Dr. Charles Tahan

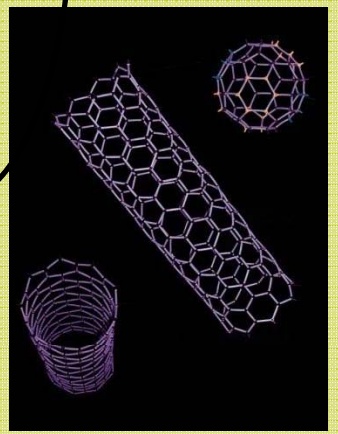
10^{-6}

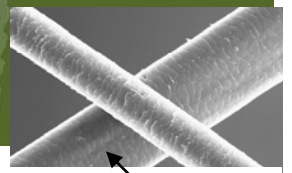
micrometers



10^{-9}

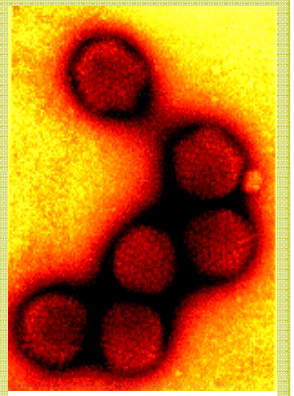
nanometers



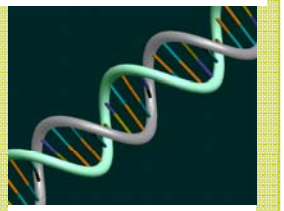


Hair ~40 microns

Bacteria: 3-5 microns



Virus: 3-50 nm



DNA: 1-2 nm diameter

1 nm = 10 Hydrogen atoms:

Nano Fun Fact

In the time it takes to read this sentence, your fingernails will have grown approximately one nanometer (1 nm).

So how small is a nanometer?

If you could paint a gallon of paint one nanometer thick, how much area would it cover?

?

Very, very, very small !!

A gallon of paint could cover the entire Arlington National Cemetery one nanometer thick.

Why Nanotechnology?

Smallness Leads to New Properties

Bulk Aluminum

Nano Aluminum

Color
Melting point
Strength
Conductivity
Reactivity

Bulk Gold

Nano Gold

Big Potential = Jobs and Careers

Medical Applications

Information Technology

Energy Solutions

Water Desalination

Why Nano Education

Drawbacks

Not inherently interesting – compared to dinosaurs or Body Worlds

Below visible threshold

Unexpected properties

Advantages

Cutting-edge

Future jobs and careers

Fundamental science

Breaks down disciplinary boundaries

Fun!

Where is Nanotechnology?

Nanotechnology All around Us and Nanotechnology the Enabler

www.nanotechproject.org/inventories/consumer

Everyday Nanotechnology: Nano Bag

What They Say

The best of Art and Nanotechnology, RxNano Handmade Bags (Nano Handmade Knit Wool Handbag)

Features:

1. Beautiful & Unique Design
2. Non hazardous Material (100% Safety)
3. Wool & Polyester with Super VLR-Photocatalyst
4. High Performance in Self Cleaning from germ, chemicals and dust in the air. (Excellent Antiseptic, Deodorization, Air Purification, Anti-UV)

Unique selling point: RxNano handmade bags are combined with the next generation photocatalyst (nanotechnology) and beautiful & unique design (handmade). They are art and hi-technology products.

Everyday Nanotechnology: Deletum 5000 Anti-Graffiti Paint

What Others Say

Deletum 5000's special ingredient is silica. It is loaded with particles of the stuff that are but a few nanometres (billionths of a metre) across. These particles have had both oil-repellent and water-repellent molecules attached to their surfaces. [. . .]

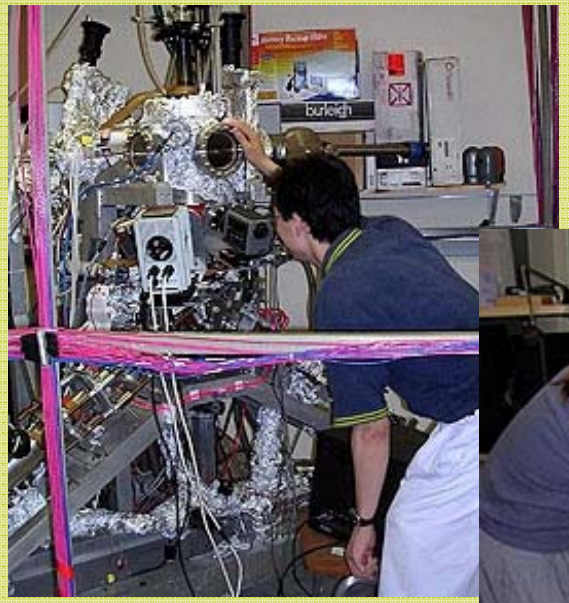
The result is that most agents used by graffiti artists will not stick to that surface—and what does stick can be washed or brushed off easily.

A Lot Still in the Lab

Current and former graduate students at the University of Wisconsin

Nancy Karuri

Karien Rodriguez

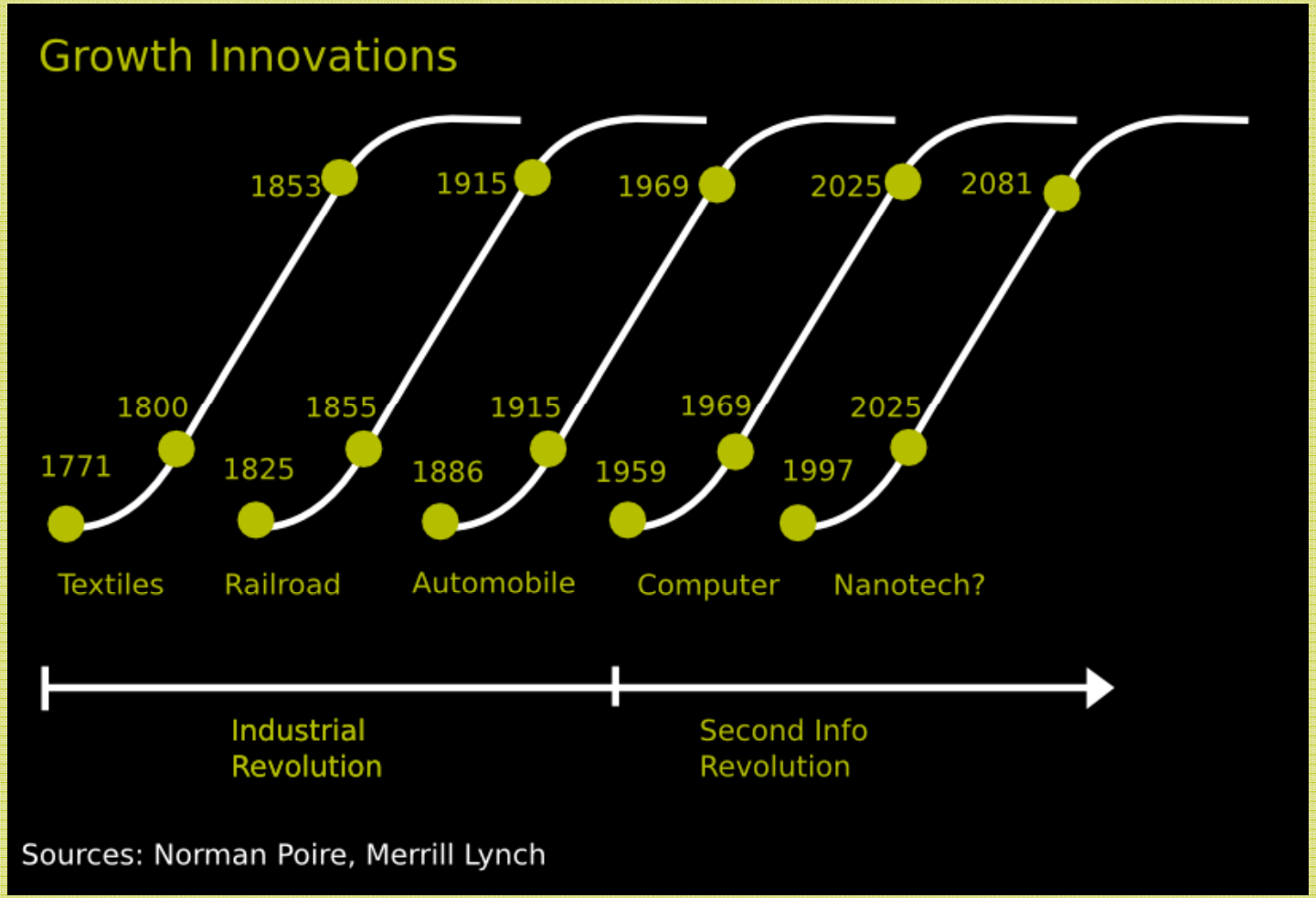


Bin Yang

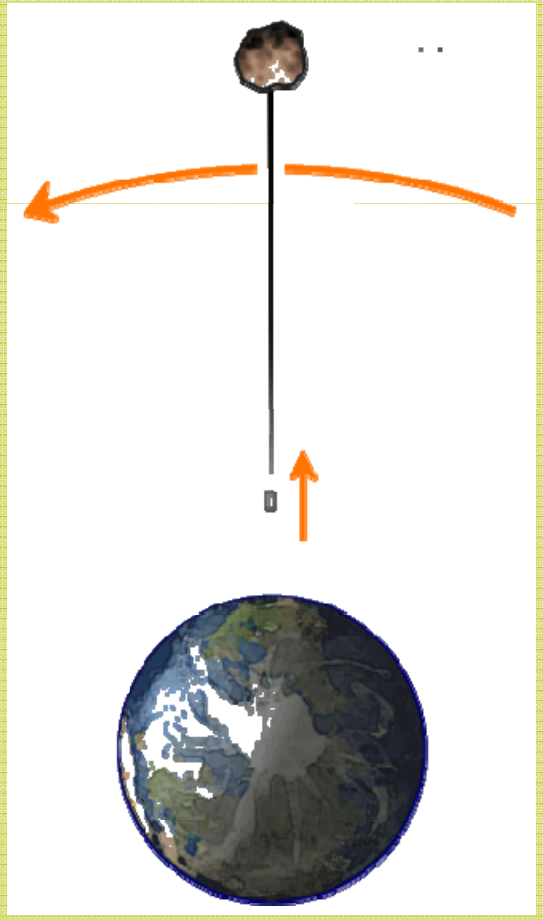
Brian Clare

Rachel Cannara

Nanotechnology's Future: In Development

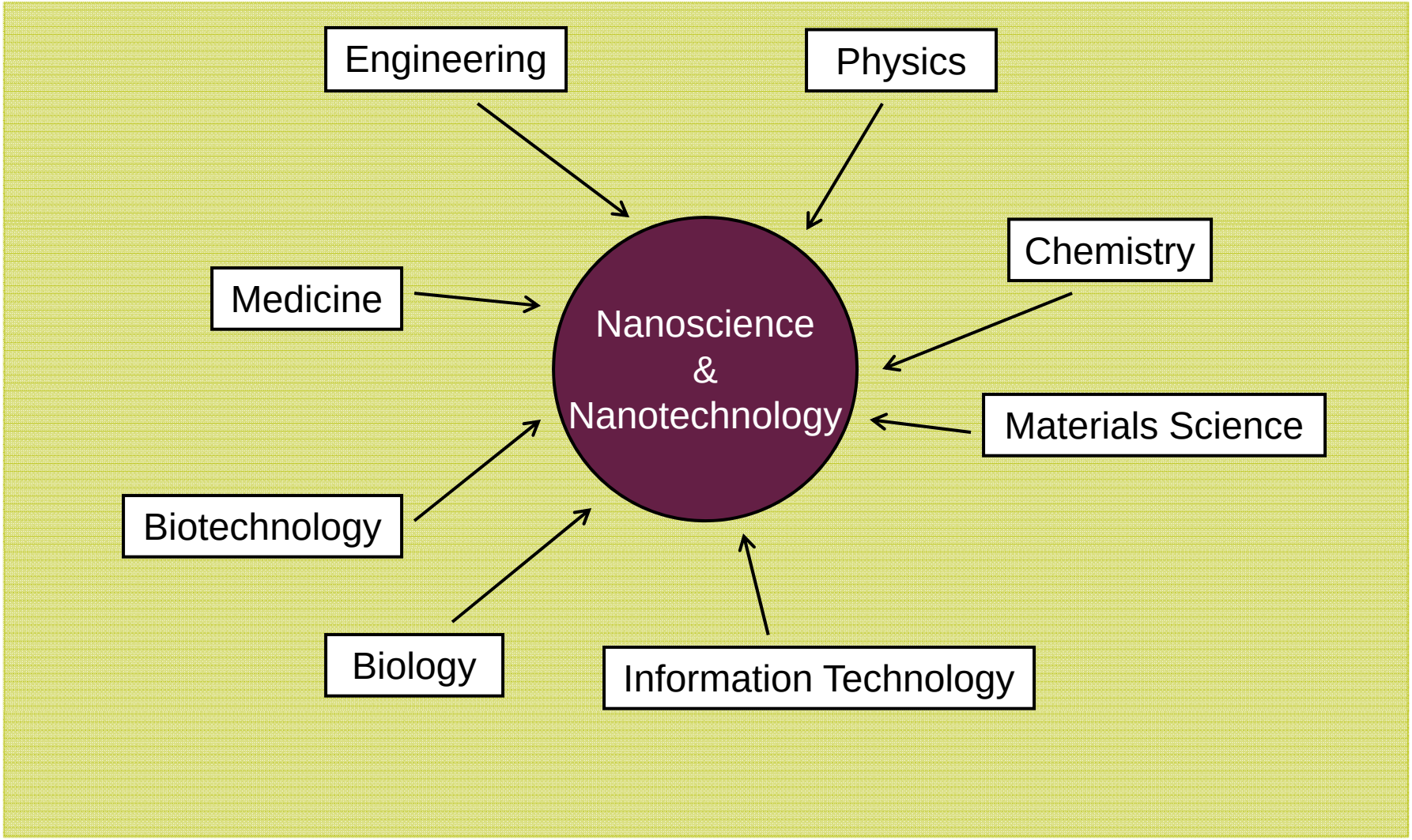


Nanotechnology's Future? Deciding Where to Go

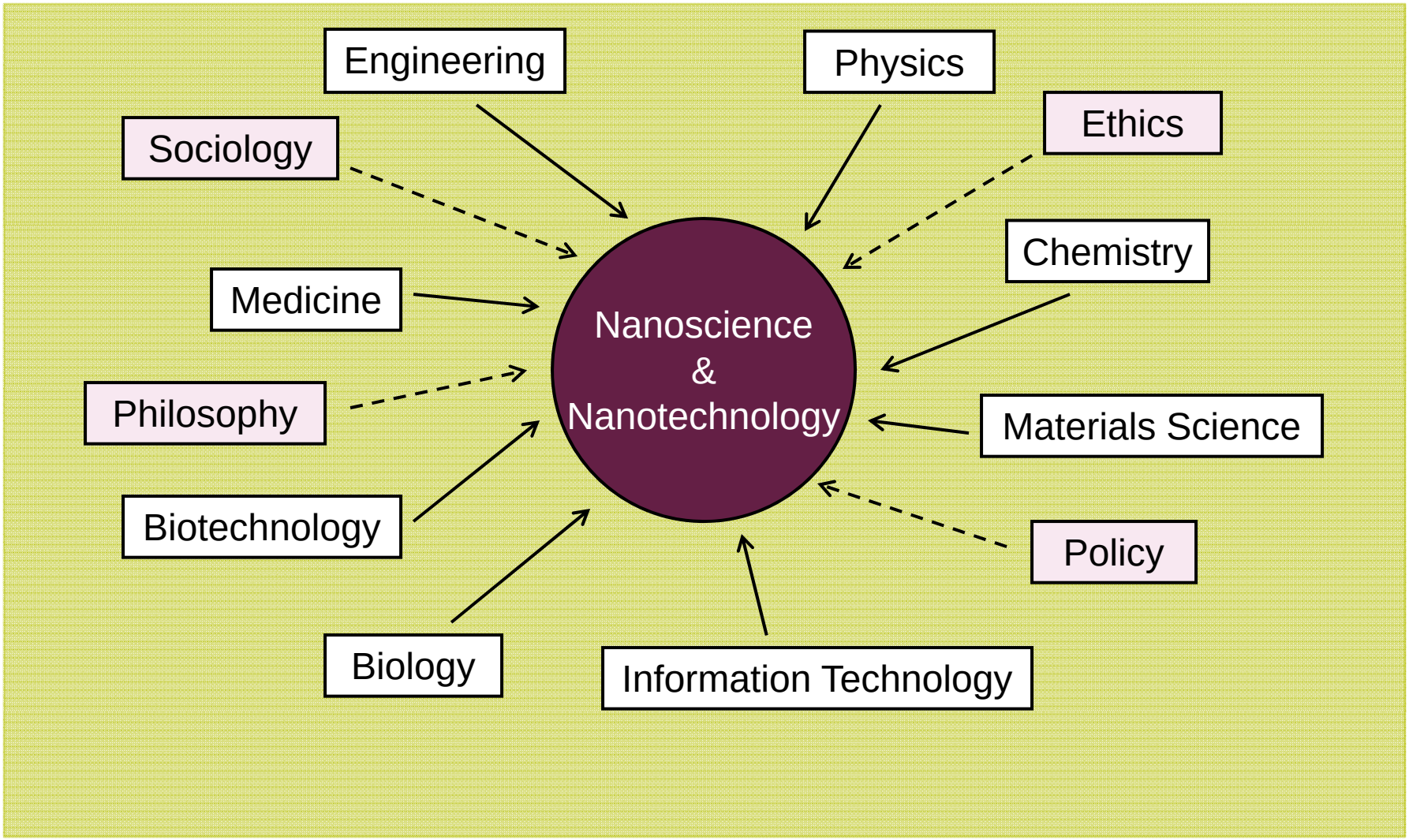


Who does nanotechnology?

An Interdisciplinary Endeavor



An Interdisciplinary Endeavor

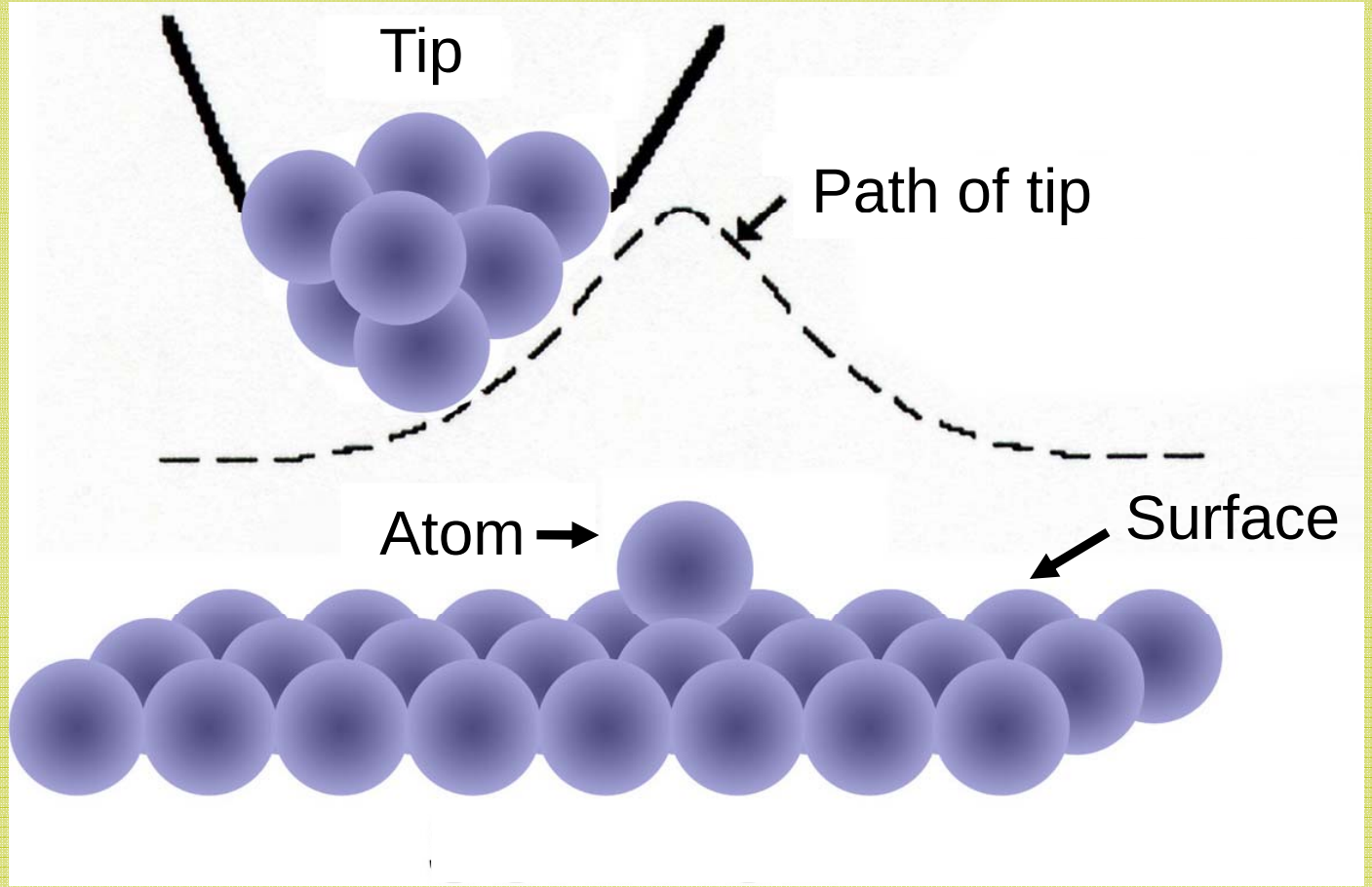


Nanotechnology Research in Many Environments

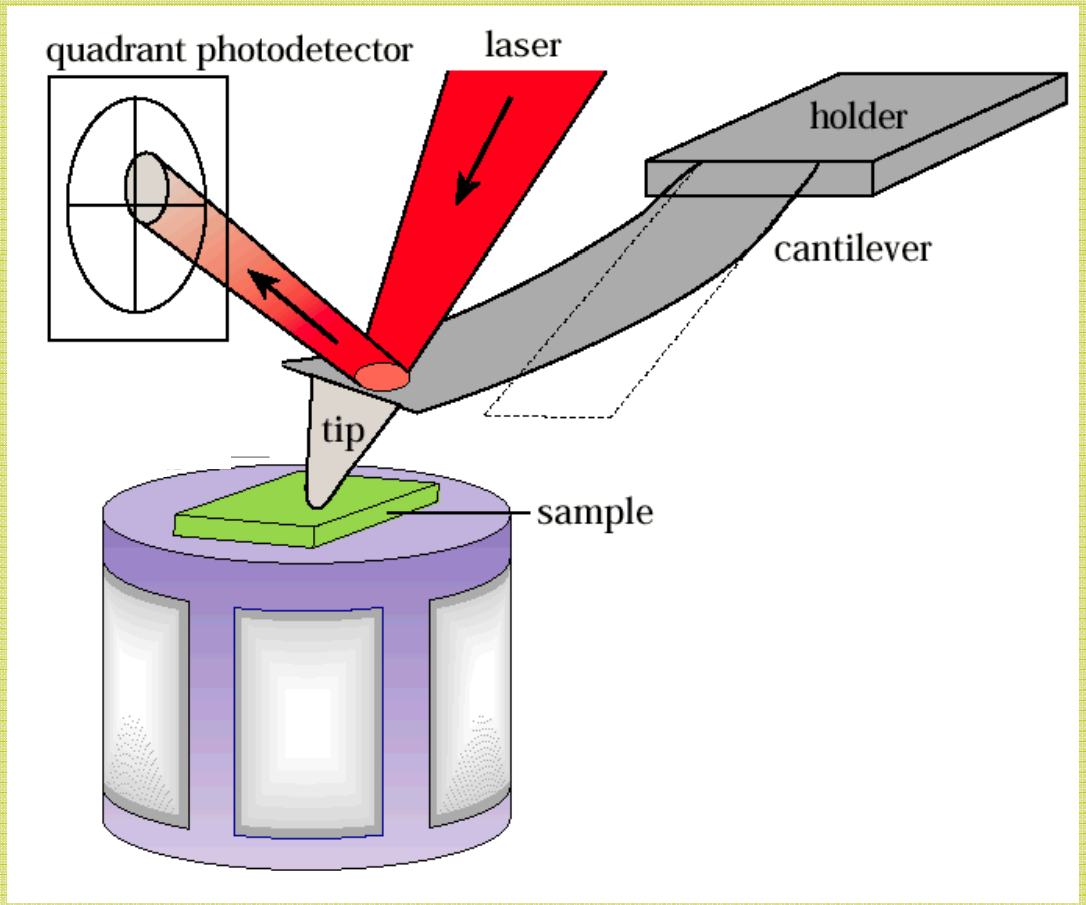
- Universities
- Industries
  - Large companies
  - Start-ups
- Government Labs
- Range of educational levels
  - Not just Ph.D.s!
- Range of disciplines
  - Including policy, art, social sciences

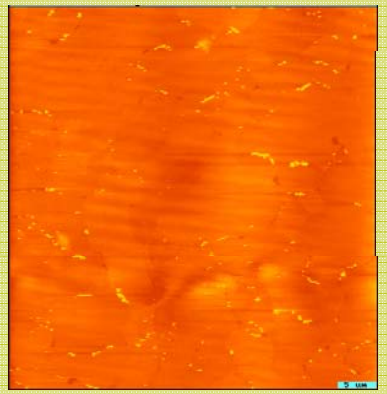
How do researchers work at the nanoscale?

Scanning Probe Microscopy (SPM): “Feeling” a Surface

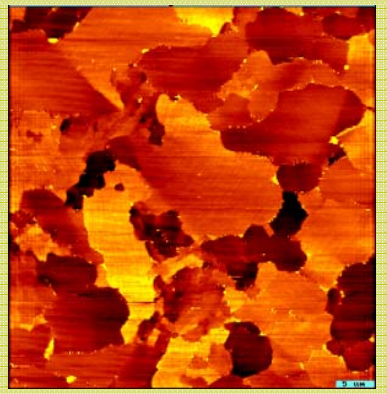


SPM: Measuring Properties





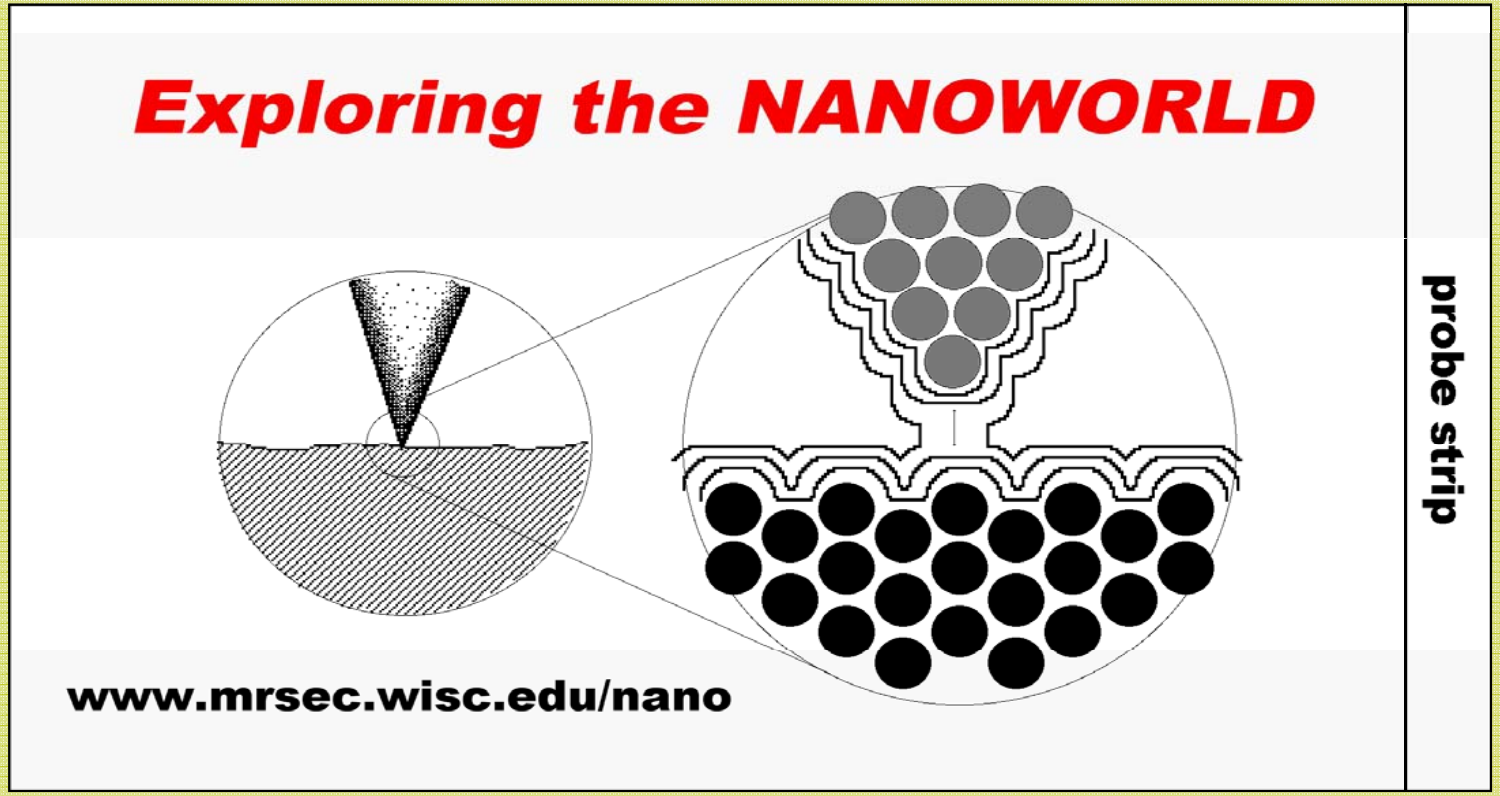
topography



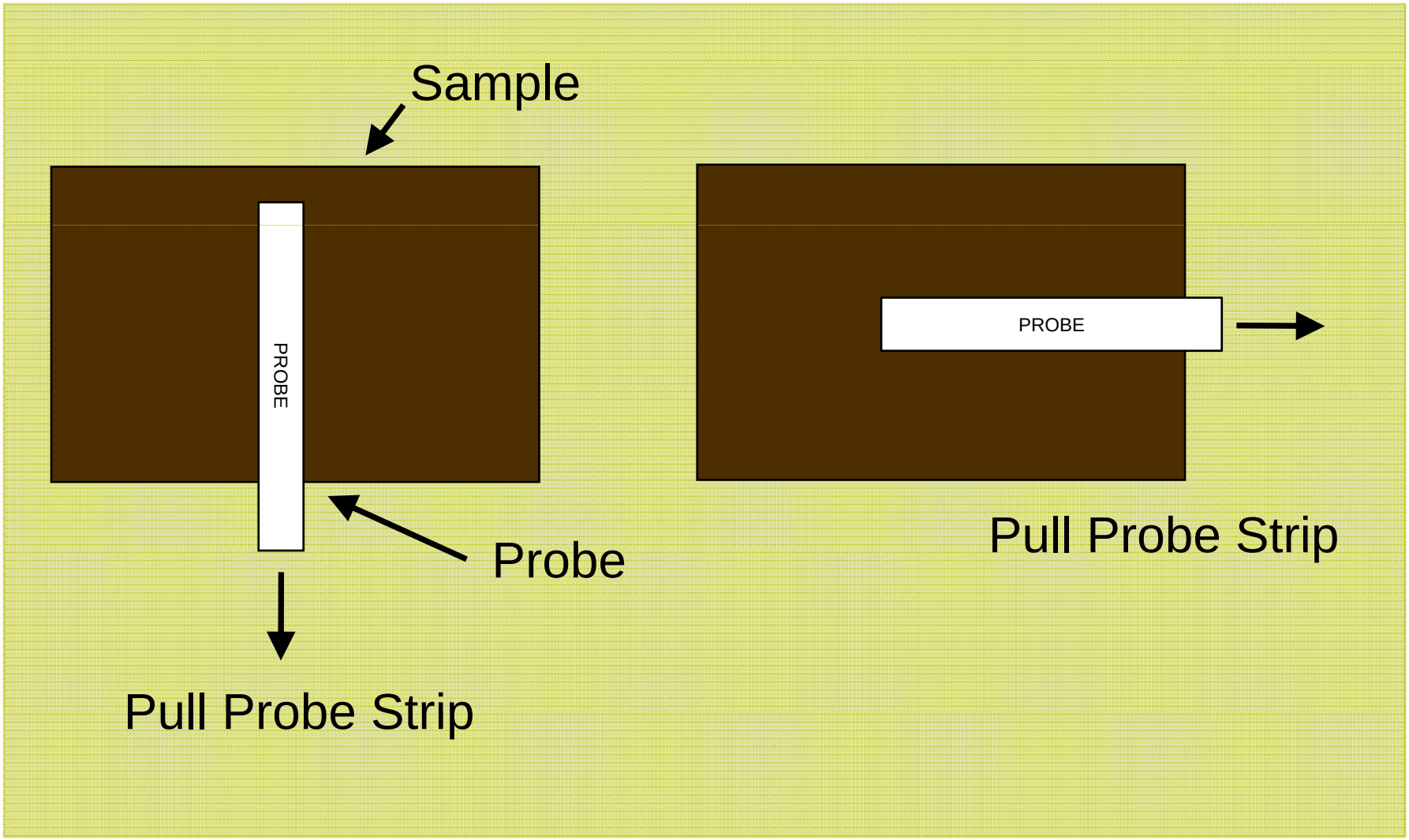
friction

50x50 µm² images
Diamond surface
sliding direction

Imaging the Nanoscale: Understanding without Seeing



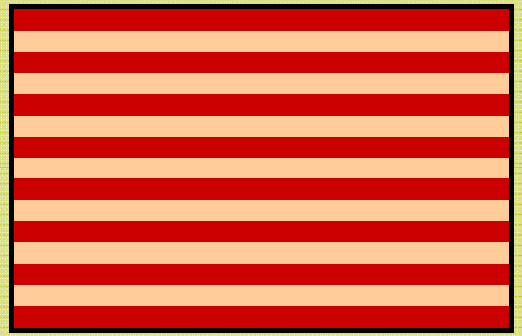
Imaging the Nanoscale: Understanding without Seeing



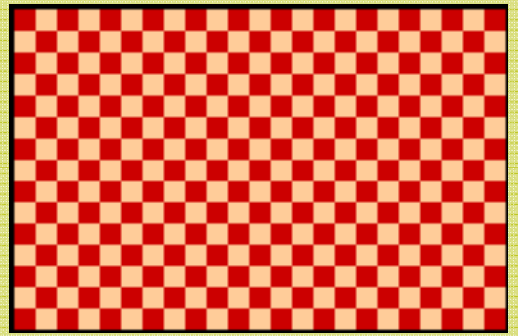
Which best represents the poles?

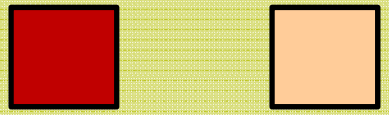
(a)

(b)



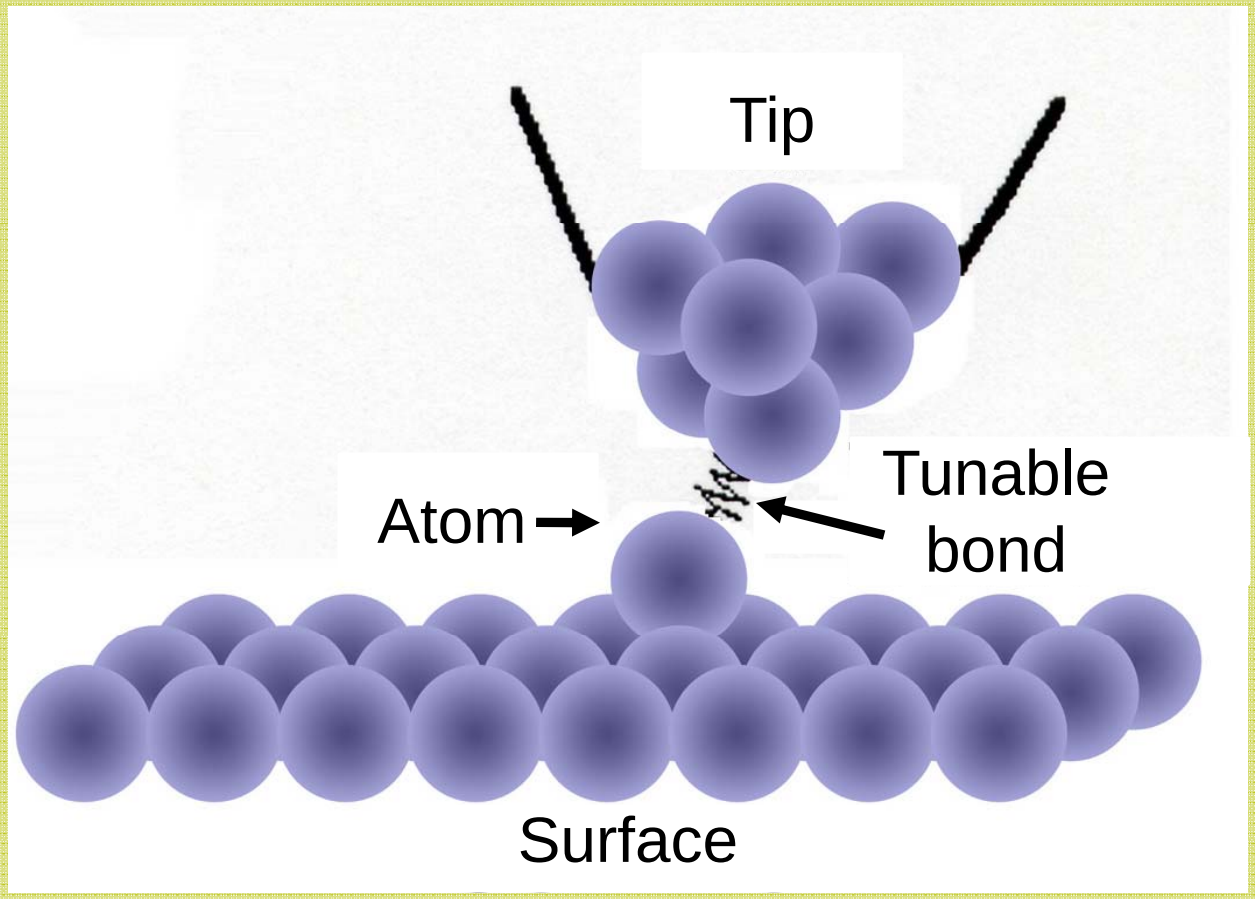
(c)



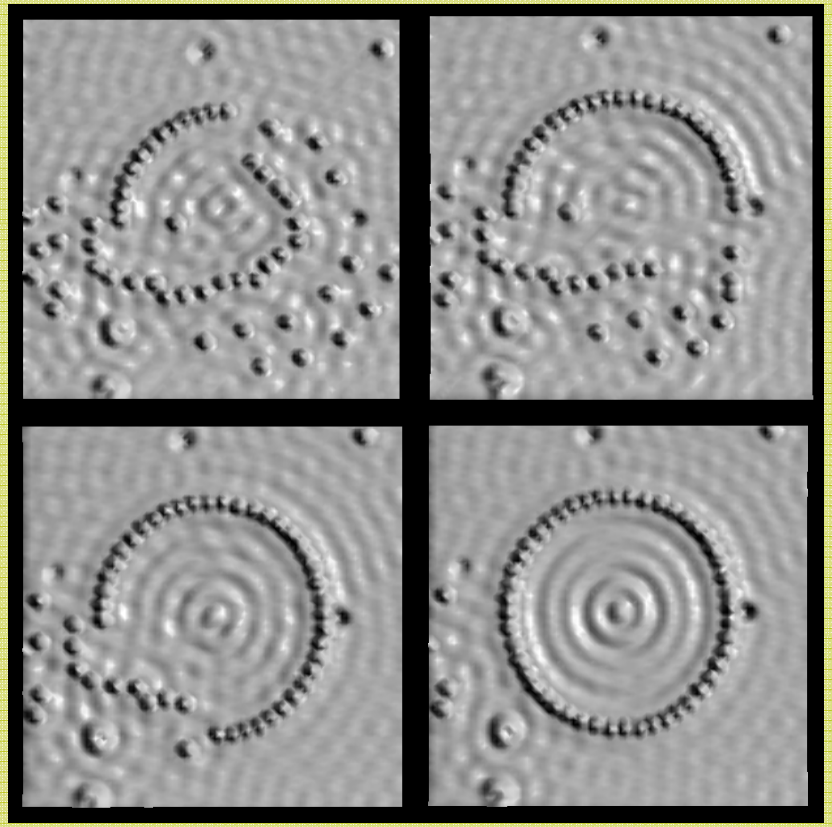


North South

SPM: Moving Atoms

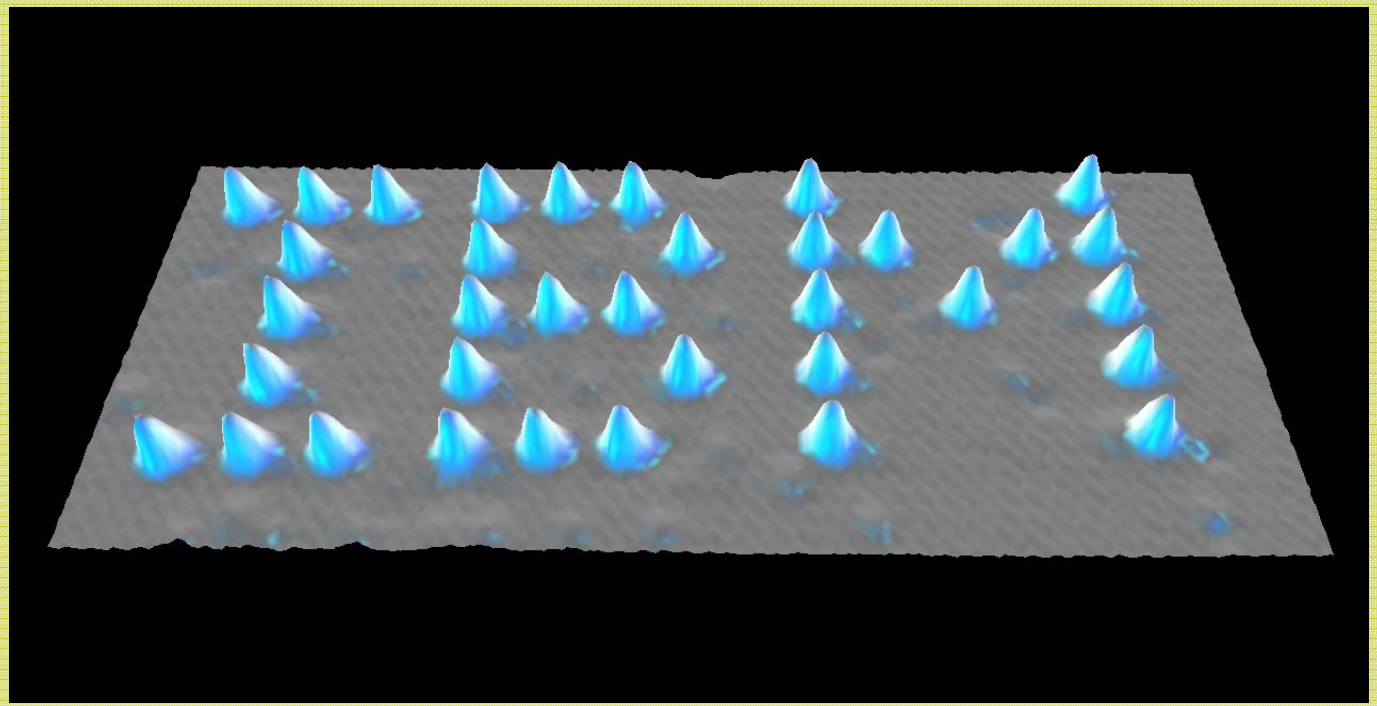


SPM: Moving Atoms into Quantum Corrals

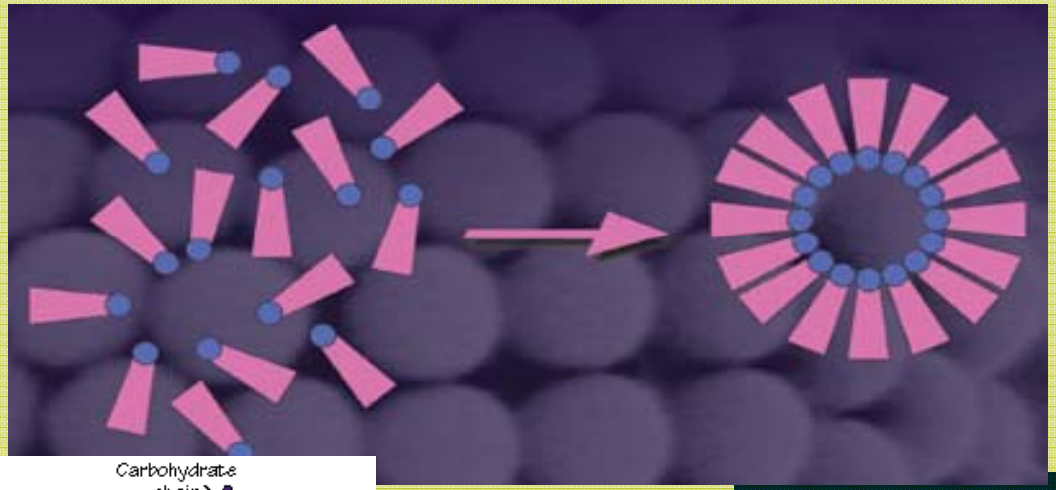


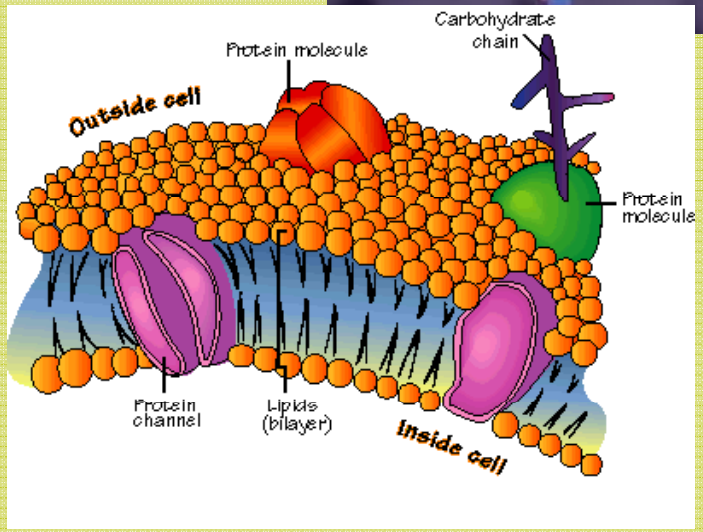
IBM

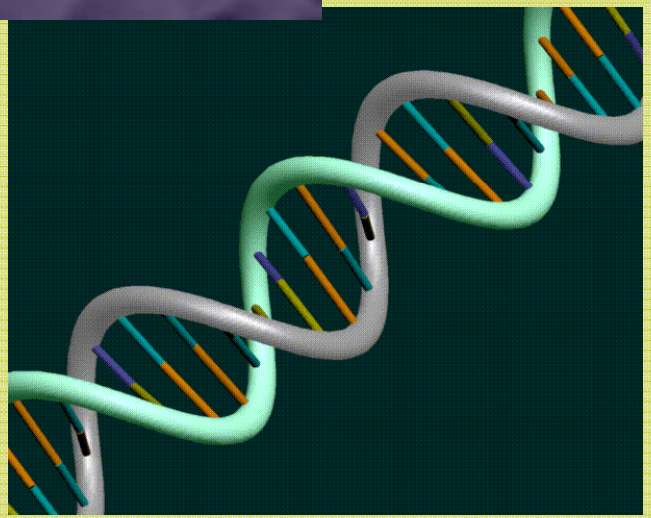
Cool, but a Slow Way to Go



Self-Assembly







Summary

What	Small, different, new Scale of the nanometer, one billionth of a meter Everyday and exotic
Why	Big potential and big impact Fun!
Who	Lots of people from a variety of disciplines You!
Where	In the lab and in the marketplace Your institution!
How	Beyond light microscopes; SPM NISE Net!

Acknowledgments

NISE Net & UW MRSEC Personnel and Collaborators

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NSF Materials Research Science and Engineering Center on Nanostructured Interfaces (DMR-0079983 and DMR-0520527)
NSF Internships in Public Science Education (DMR-0120897 and DMR-0424350)

Thank You!

Your name

Your_email@someplace.com

www.yourwebsite.com

www.nisenet.org

References

Slide 5: Nano Not Widely Understood

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Slide 9: Nano Fun Fact, www.starling-fitness.com/wp-content/P1030148.jpg

Slide 11: Very, very, very small!, www.usconstitution.com/arlingtonnational.htm

Slide 22: Deciding where to go, en.wikipedia.org/wiki/Space_elevator

Slide 24-5: Who Does Nano, Based upon www.kuleuven.be/nanotechnology/taart.gif

Slide 25: Who Does Nano, pt 2, C. Miller et al., "Nanotechnology & Society: Ideas for Education and Public Engagement." http://mrsec.wisc.edu/Edetc/society/nano_and_society.pdf

Slide 28: SPM: "Feeling," G. Timp. *Nanotechnology*. 1999.

Slide 29: SPM: Measuring Properties, R. Carpick, UW/U Penn.

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Slide 34: Quantum Corral, M.F. Crommie, C.P. Lutz, D.M. Eigler. Confinement of electrons to quantum corrals on a metal surface. *Science* 262, 218-220 (1993). www.ibm.com

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