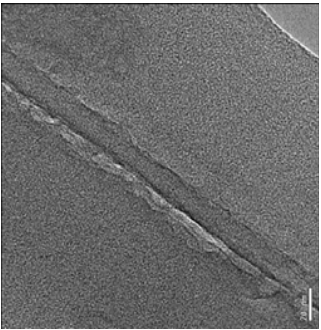




The 2<sup>nd</sup> Workshop on  
**Visualization of Nanotechnology**  
 Pennsylvania Junior Academy of Science (PJAS)  
**October 11, 2008**



**Schedule**

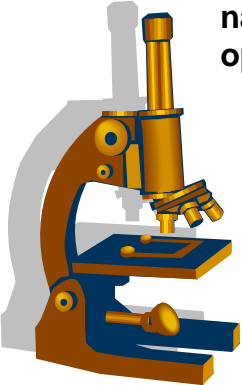
9:00 – 9:20	Welcome and Refreshments
9:20 – 9:50	Presentation “Introduction to Nanotechnology”
9:50 – 10:00	Break
10:00 – 11:40	Small Group Lab Experience and Tour
11:40 – 12:00	Survey and Ending

**Lab Experience and Tour**

Time	Team 1		Team 2	
	Group A	Group B	Group C	Group D
10:00 – 10:25	Clean Room Characterization	Clean Room Fabrication	NEDL Lab - 462 BEH	SEM Lab - 865 BEH
10:25 – 10:50	Clean Room Fabrication	Clean Room Characterization	SEM Lab - 865 BEH	NEDL Lab - 462 BEH
10:50 – 11:15	NEDL Lab - 462 BEH	SEM Lab - 865 BEH	Clean Room Characterization	Clean Room Fabrication
11:15 – 11:40	SEM Lab - 865 BEH	NEDL Lab - 462 BEH	Clean Room Fabrication	Clean Room Characterization

Description

**Nanotechnology is a new and emerging area of science that has the potential to create devices with totally new capabilities. The goal of this laboratory is to provide a scientific basis for understanding nanoscience and nanotechnology. By participating in this introductory laboratory experience, high school students will have an opportunity to:**



1. Gain an accurate understanding of nanotechnology concepts and principles;
2. Observe the operation of an Atomic Force Microscope (AFM) that has the capability of seeing nanometer objects (1nm = 10<sup>-9</sup> meter);
3. Tour the Petersen Institute of NanoScience and Engineering (PINSE) which is a state-of-the-art facility with extensive nanofabrication and characterization capabilities;
4. Indicate an interest in conducting a follow-up nanotechnology related science project.



# The Scale of Things - Nanometers and More

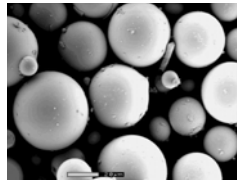
## Things Natural



Dust mite  
200 μm



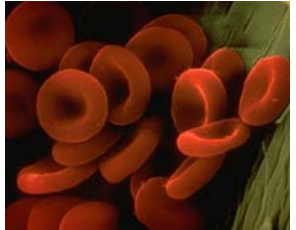
Ant  
~ 5 mm



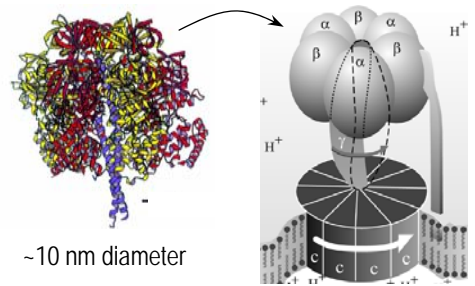
Fly ash  
~ 10-20 μm



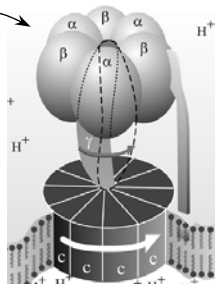
Human hair  
~ 60-120 μm wide



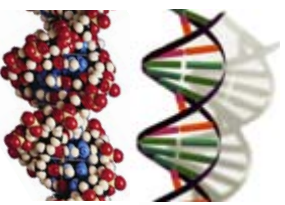
Red blood cells  
(~7-8 μm)



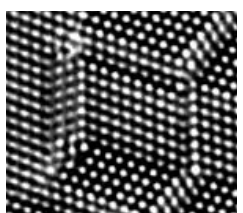
~10 nm diameter



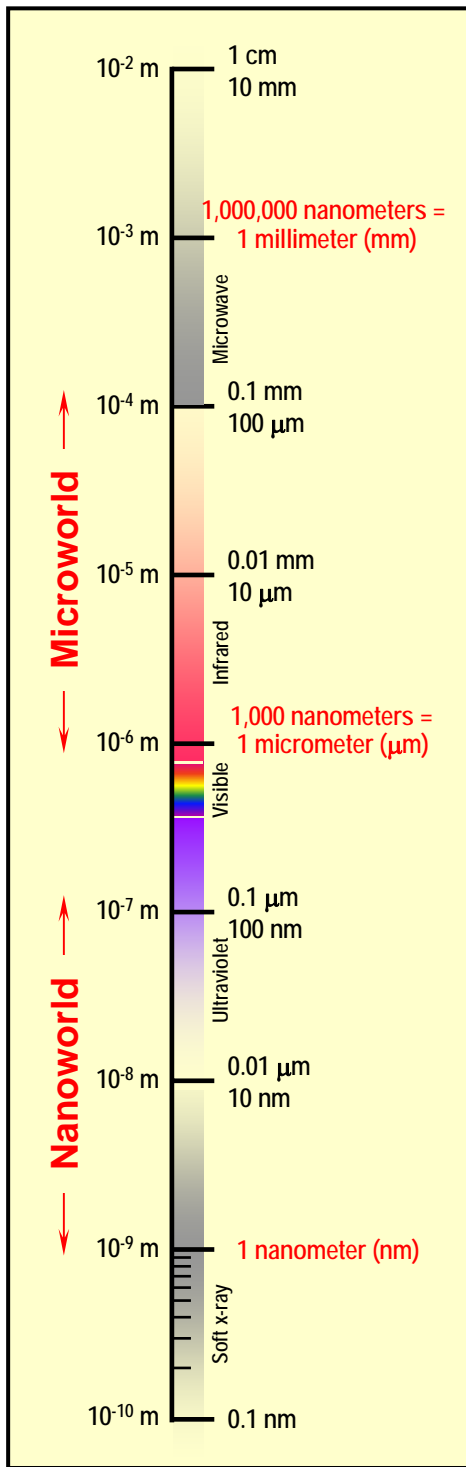
ATP synthase



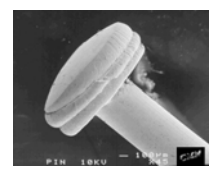
DNA  
~2-1/2 nm diameter



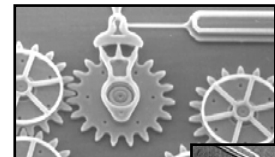
Atoms of silicon  
spacing ~tenths of nm



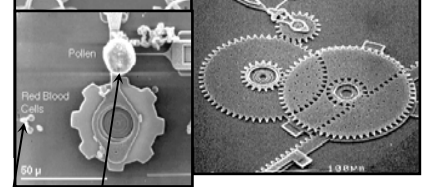
## Things Manmade



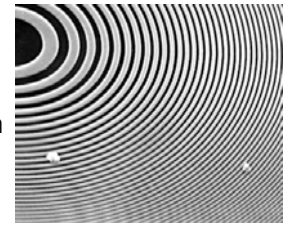
Head of a pin  
1-2 mm



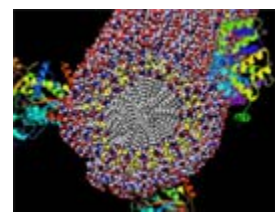
MicroElectroMechanical (MEMS) devices  
10 -100 μm wide



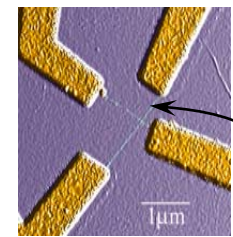
Pollen grain  
Red blood cells



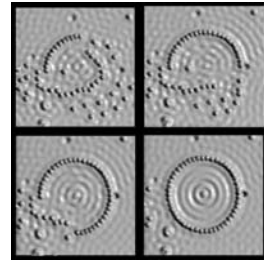
Zone plate x-ray "lens"  
Outer ring spacing ~35 nm



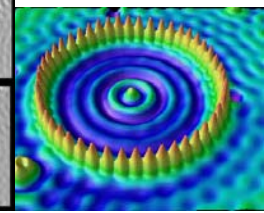
Self-assembled, Nature-inspired structure  
Many 10s of nm



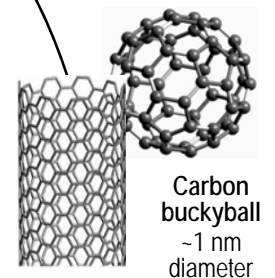
Nanotube electrode



Quantum corral of 48 iron atoms on copper surface  
positioned one at a time with an STM tip  
Corral diameter 14 nm



Carbon nanotube  
~1.3 nm diameter



Carbon buckyball  
~1 nm diameter

### The Challenge

*Fabricate and combine nanoscale building blocks to make useful devices, e.g., a photosynthetic reaction center with integral semiconductor storage.*